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The Soil and Water Conservation Research Division works in cooperation with State Agricultural Experiment Stations.

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Report for April-June 1958 Issued July 1958

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New Jersey

RESPONSE TO IRRIGATION OF VEGETABLES VARIES WITH CROP

G. D. Brill, New Brunswick.--In a study at Marlboro, N. J., cabbage, sweet corn, cantaloupes, and snap beans were irrigated at three levels of soil moisture consisting of no irrigation, moderate irrigation, and frequent irrigation. The soil was brought to field capacity at each irrigation.

Rainfall during the 1957 growing season, May through October, was 10.25 inches; 14.43 inches less than the 20-year average. This was the driest season recorded for this area.

Cabbage was irrigated 9 times under the frequent treatment using a total of 12.3 inches of water and 4 times under the moderate treatement using 8.7 inches of water. Without irrigation, no marketable heads of cabbage were produced.

Sweet corn was irrigated 11 times under the frequent treatment, and 5 times under the moderate treatment, using 15.0 and 11.00 inches of water, respectively. In addition, 1.0 inch of water was applied to both treatments immediately after planting to hasten germination.

Cantaloupes were irrigated 7 times under the frequent treatment and 3 times with the moderate treatment, using 9.0 and 6.0 inches of water. Frequent irrigation did not increase the yield of either sweet corn or cantaloupes as compared to moderate irrigation.

Fall snap beans following cabbage were irrigated 4 times under the frequent and twice under the moderate treatment, using 5.3 and 3.5 inches of water. As with cabbage, frequent irrigation gave a significant increase in yield, large enough to compensate for the extra time and water used.

With all crops, quality was poor without irrigation. Except for cabbage, some marketable produce was obtained, but probably, not enough to pay production costs.

Response to irrigation of vegetable crops at Marlboro, N. J., 1957

Crop	Yield increase per acre	
	Moderate irrigation	Frequent irrigation
	Tons	*Tons*
Cabbage.....	13.9	18.7
Sweet corn.....	4.5	4.5
Cantaloupes.....	7.8	8.3
Snap beans.....	1.1	2.3

Alabama

IRRIGATION AND FERTILIZATION NEEDED FOR HIGH SILAGE YIELDS

Orus L. Bennett, Thorsby. --Yields of approximately 50 tons of silage per acre were produced by Sart sorghum and Star millet by using high fertilization, maintaining a high soil moisture level, and taking advantage of most of the frost-free growing period.

Data in the accompanying table show the average yields of silage (green weights) of Sart sorghum, Star millet, and sweet sudangrass grown at three soil moisture levels. Yields of silage varied according to soil moisture level. Species with the highest yields were produced at the highest soil moisture level for all three species. Yields from Sart sorghum and Star millet were approximately twice those for sudangrass at all three soil moisture levels.

These yields are the result of two plantings of each species grown on the same soil during the same growing season. The first planting was made on April 20 and the second planting on August 1. Each crop was fertilized with 200 pounds of N and 1,000 pounds of 0-10-20 per acre for a total of 400 pounds of N and 2,000 pounds of 0-10-20 per acre for each growing season.

Two years data indicate that extremely high yields of silage can be produced by using a combination of irrigation applied at the proper time, high fertilization, and double-cropping, when adapted silage species are used.

Effect of three soil moisture levels on yields of silage for three plant species--1956-7 average, Thorsby, Ala.

Species	Yields of silage (green weight) per acre[1]		
	M_1[2]	M_2	M_3
	Pounds	*Pounds*	*Pounds*
Sudangrass.....	29,477	48,137	52,856
Star millet.....	55,341	86,125	99,791
Sart sorghum.....	47,186	92,250	101,994

[1] Total for two plantings.
[2] M_1 Not irrigated.
M_2 Irrigated when soil moisture tension reached 4 atmospheres.
M_3 Irrigated when soil moisture tension reached 2/3 atmospheres.

Texas

GRAVEL PACK CONTROLS PUMPING OF SAND IN WELL

M. E. Jensen, Bushland. --A gravel pack effectively controlled the pumping of fine sand from a water-bearing aquifer in a new well on the Southwestern Great Plains Field Station, Bushland, Texas. Analysis of the water-bearing sand indicated an average 50 percent diameter of 0.37 mm. and a D_{60}/D_{10} ratio of 2.0.* Less than one-half percent of the sand had a diameter greater than 1 mm.

*D_{50} = medium size, 50 percent larger, 50 percent smaller.

D_{60} = size at which 60 percent is smaller.

D_{10} = size at which 10 percent is smaller.

The gravel pack used had a 50 percent diameter of 4.5 mm. and a D_{60}/D_{10} ratio of 1.9, resulting in a pack-aquifer ratio (D_{50} particle size) of 12. A 16-inch steel casing with 1/8-inch slots was used in the 30-inch diameter well.

At the end of the pumping test, there was less than 5 p. p. m. sand when pumping 805 g. p. m. Controlling sand in irrigation wells will increase the life of the pump bowls and result in more efficient pumping systems.

New Mexico

MOISTURE STRESS DELAYS SQUARING OF COTTON

Ross W. Leamer, State College. --The effects of high moisture stress at various stages of plant development are being studied on the rate of fruiting and yield of cotton. Three cotton plants are being grown in each of 50 pots (10 gallon garbage pails) containing 100 pounds of soil. Plants in various pots are being allowed to suffer severe moisture stress at different stages of growth. One group of plants was under stress from emergence (April 23) to the appearance of the first square (June 16). Another group was under stress from the appearance of the first square until blossoms appeared (July 1). A third group was under stress for three weeks following the appearance of the first blossom. All these receive ample water during the rest of the growing season. Another group of plants is irrigated only after they show signs of moderate stress (slight wilting during the day and the typical color change in the leaves) all during the season. All these are compared to a group receiving ample moisture (tension less than 700 cm.) all season.

The rate of fruiting is measured by counting the new squares three times each week. The accompanying graph shows that moisture stress--severe or slight--reduces the number of squares set up to the time of this report.

The rate of setting new squares drops as soon as moisture stress develops. Once plants have been subjected to stress, the rate does not increase as soon as the stress is relieved. Those plants which were dry early in the season but received ample water during squaring produced no more squares than those under severe stress during this period. Periodic moderate stress also keeps the fruiting rate down.

Nevada

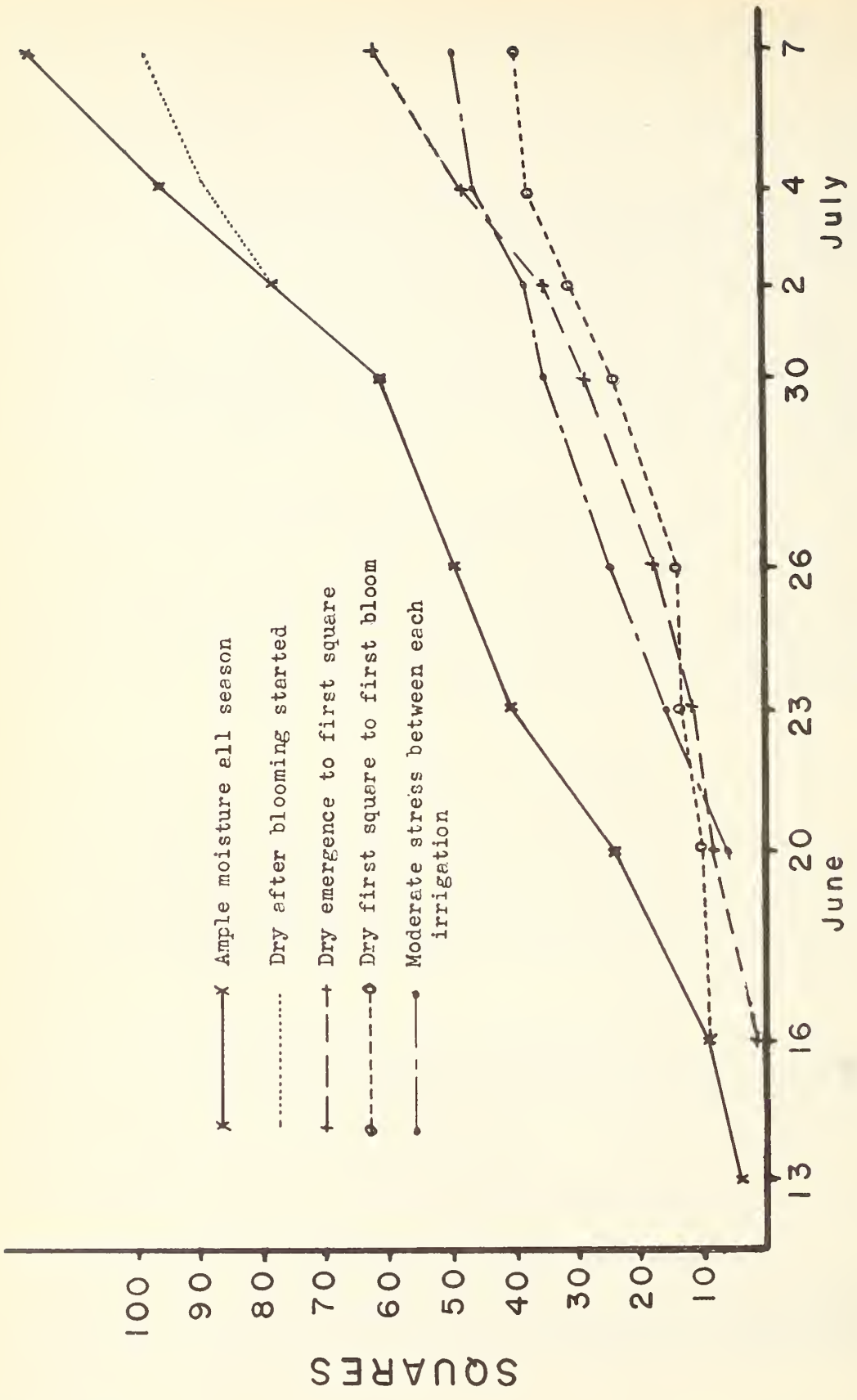
CONSUMPTIVE USE MEASURED FOR SALT GRASS

Victor I. Myers and Rhys Tovey, Reno. --Studies in southern Nevada indicate that density of stand must be considered in estimating consumptive use of water by salt grass. Salt grass is being grown in tanks at Caliente, Logandale, and Bunkerville, Nevada, with a water table constantly maintained two feet below the soil surface. Three tanks are maintained at each location. Reliable data were obtained after June 15 and provide a good comparison of consumptive use under various conditions at the three locations. Prior to June 15, difficulty was experienced in maintaining a constant water level, resulting in unreliable data.

The salt grass tanks at each location are placed in an enclosure with meteorological instruments. At each site, records are made of temperature, humidity, wind, rainfall, pan evaporation. Temperature, pan evaporation, and salt grass consumptive use and yield data are shown for three southern Nevada locations in the accompanying table.

Salt grass has been grown in tanks at many locations over the past several decades. A great variation in consumptive use has been reported, it generally being implied that the variation is due to climatic differences.

Some interesting differences in salt grass consumptive use are found at two locations, Bunkerville and Logandale, where the average temperatures for the period of measurements are nearly the same. The salt grass at Logandale consumed 32.25 inches more water than did the salt grass at Bunkerville. Obviously, the comparative density of the salt grass stands had a great deal to do with the differences of consumptive



Effect of moisture stress on number of cotton squares set per pot, State College, N. Mex., 1958

use. The value of consumptive use for Caliente was 4.52 inches greater than that at Bunkerville, even though the average temperature at Caliente for the period was 11 degrees cooler. Here, again, the difference is probably due to the more dense stand of salt grass at Caliente.

Salt grass consumptive use and weather data, June 21 to Sept. 11, 1957, for three sites in southern Nevada

Location	Consumptive use of salt grass	Av. salt grass yield per tank*	Average temp. for period	Total pan evaporation
	Inches	*Grams*	°F	*Inches*
Caliente.....	24.67	103	74.5	28.77
Bunkerville.....	20.15	79	85.5	29.91
Logandale.....	52.40	670	84.6	26.11

*Tanks are 22.5 inches in diameter.

In transplanting salt grass to the tanks, clean stands were selected. The main objective was to obtain salt grass from a uniform stand that was free from Bermuda grass. Observations of the original plantings did not suggest such a wide variation in the density of stand at the three locations.

These results suggest that, in order for tank consumptive use data to be of value for estimating consumptive use on a large scale areal basis, some measurement of the density of stand in both the tanks and from the field must be available.

Idaho

HYDRAULICS OF SURFACE IRRIGATION STUDY INITIATED

James A. Bondurant, Boise.--Studies to determine the effects of rate of water application, intake rate, slope, and roughness on the advance and recession rates under surface irrigation methods have been started. The initial phases of the study are to be conducted in the laboratory, where the effects will be evaluated by model studies. A glass-walled flume having separate sections simulating the soil and the flow channel will be used.

Precisely leveled plots with 0 percent, 1 percent, and 5 percent slopes will be established for the field phase of this study. Slope, rate of application, and intake rate effects determined in the laboratory will be evaluated and adapted to field conditions. Roughness and channel shape effects will also be evaluated in the field phase of the study.

DRAINAGE

Florida

PLASTIC-LINED MOLE DRAINS INSTALLED FOR STUDY IN SANDY SOIL

L. C. Hammond, J. M. Myers, Gainesville, and H. A. Weaver, Fort Lauderdale.--Approximately 16,500 feet of 3-inch diameter vinyl plastic mole liners have been installed in typical poorly drained sandy Flatwoods soils at Gainesville. The utility of the low-cost plastic tubes will be tested for both drainage and subirrigation.

Drainage studies will involve chiefly the measurement of rate of water table drawdown for drains spaced 20 and 40 feet apart and placed at an average depth of 21 inches.

Measurements of tile discharge rates will be made where practicable. Subsurface irrigation studies will involve the measurement of crop response and soil moisture distribution for two constant and one fluctuating water table level supplied with water through plastic-lined tubes spaced 10 feet apart.

The procedure and experimental equipment designed to place the plastic tile in the soil was developed jointly by ARS and Cornell University. Basically, the plastic is fed off a reel as a sheet 10 or 11 inches wide, through a chute and rollers; and, finally, emerges as a cylinder in the soil opening formed by a mole tool. The mole and liner apparatus are interconnected and are attached as a unit to the drawbar of a crawler type tractor capable of installing the drain at a speed of 1 m. p. h.

The Flatwoods areas of Florida comprise many thousands of acres of sandy land which have production potential if properly drained. In most cases, the marginal value of this land precludes the use of conventional tile drains. Hence, there is a need for developing low-cost water management practices for such areas.

North Carolina

DRAIN DEPTH AND SPACING REPORTED FOR COASTAL PLAINS

Jan van Schilfgaarde, Raleigh. --Adequate drainage can be obtained in certain parts of North Carolina with drain depths of 2 to 4 feet and spacings up to 200 feet. This was shown by long-term field observations on cropland along the Eastern Coastal Plain, primarily on Portsmouth loam and fine sandy loam. Measurements in land with open and closed drains at various depths and spacings showed that the water table would seldom fail to recede to at least 1 foot below the surface, unless the drain depth was less than 2 feet.

No difference was observed in the effectiveness of open or closed drains or open drains constructed by different methods. Soil variability and insufficient replication made it impossible to establish a clear relation between water table depth and depth or spacing of drains.

The data have just been published as N. C. Tech. Bull. 133.

Ohio

STUDY STARTED ON HYDRAULIC CONDUCTIVITY OF HUMIC GLEY SOILS

T. J. Thiel, G. S. Taylor, and N. Holowaychuk, Columbus. --The need for land drainage in the humid regions generally results from the occurrence of slowly permeable layers within 6 to 10 feet of the ground surface. The hydraulic conductivity of the various layers and their location in the vertical (depth) profile largely determine the extent to which drainage problems are manifest and the success in alleviating these problems by surface and subsurface drainage systems.

The saturated hydraulic conductivity profiles of some of the soils in the lakebed region of Ohio are currently being established on vertical and horizontal core samples. Unsaturated hydraulic conductivities also are being studied with a prime consideration being given to the development of an improved method of evaluating unsaturated flow.

In addition to the Humic Gley soils, the Gray-Brown Podzolic and the Gray-Brown Podzolic-Acid Brown soil groups will be studied.

California

GUIDE LINES PRESENTED FOR THE DESIGN OF INTERCEPTOR DRAINS

W. W. Donnan, Pomona.--In designing interceptor drains, the technician wants to know the answers to the following questions:

1. How deep should the interceptor drain be placed on the soil profile?

2. How far upslope from the drain will the water table drawdown be effective?

3. What is the shape of the drawdown curve downslope from the drain device?

4. How much water will be intercepted by the drain? In other words, what size tile or open drain is needed?

5. Which is most effective, an open drain or a closed (tile) drain?

The answers to these questions and a discussion of each answer form the basis of a recent paper presented for publication by American Society of Civil Engineers.

In summary, the basic concepts to be considered when designing an interceptor drain are as follows:

1. The drain device should be placed as deep as it is practical to install, except that tile drains should not be installed below the surface of any major underlying impervious boundary layer.

2. The drawdown upslope will not be very significant and will be dependent on the initial slope of the water table.

3. The drawdown downslope will be very significant and will be primarily dependent on the water level in the drain device.

4. The quantity of water intercepted will vary directly with depth of flow intercepted.

5. The open drain and the tile line are equally efficient in the removal of water except on excessively steep slopes where the open drain becomes more efficient.

These concepts will be modified by the extenuating circumstances which are inherent and, perhaps, unique in each individual problem. The designer should keep in the forefront of his thinking the idea that, in the interceptor problem, he is dealing with the diversion of an underground stream, a phenomenon at considerable variance with the ordinary drainage of irrigation or rainfall patterns.

Wisconsin

EFFECT OF SLOPE ON RUNOFF AND EROSION MEASURED

Orville E. Hays, LaCrosse.--Nineteen years of data at the Upper Mississippi Valley Experimental Station are available showing the influence of percent of slope on soil and water losses and crop yields.

In 1938, plots were established on slopes of 3, 8, 13, and 18 percent. There are 3 plots on each slope. Each plot is 72.6 feet in length and 14 feet in width. For the period 1939 to 1943, grain was planted up and down slope on all plots. During the period 1944 to 1957, the experiment was cropped to a three-year rotation of corn, grain, and one year of hay. All cultural treatments were on the contour. All plots were planted to one crop during a year.

The soil and water losses are shown in figures 1 and 2. Each datum is the average loss from three plots for the season, April 15 to November 15.

Crop yields are given in the accompanying table. Yield of crop, with the exception of hay, was not consistently influenced by steepness of slope. Hay yield decreased as the steepness of slope increased. Hay production was influenced by the amount of erosion that occurred in grain. Severe erosion, especially from rains occurring soon after the grain was seeded, reduced the hay stand and influenced the hay yields and the amounts of soil and water losses from hay.

Effect of slope on crop yields, LaCrosse, Wis., 1939-57

Crop	Planted	Units	Crop yield per acre			
			Slope percent			
			3	8	13	18
Barley.....	Up & down.....	Bushels.....	25.4	26.5	26.3	23.6
Corn.....	Contour.....	Bushels.....	76.6	75.4	83.3	73.2
Oats.....	Contour.....	Bushels.....	69.4	73.4	74.2	64.8
Hay.....	Contour.....	Tons.....	3.7	3.6	3.4	3.3

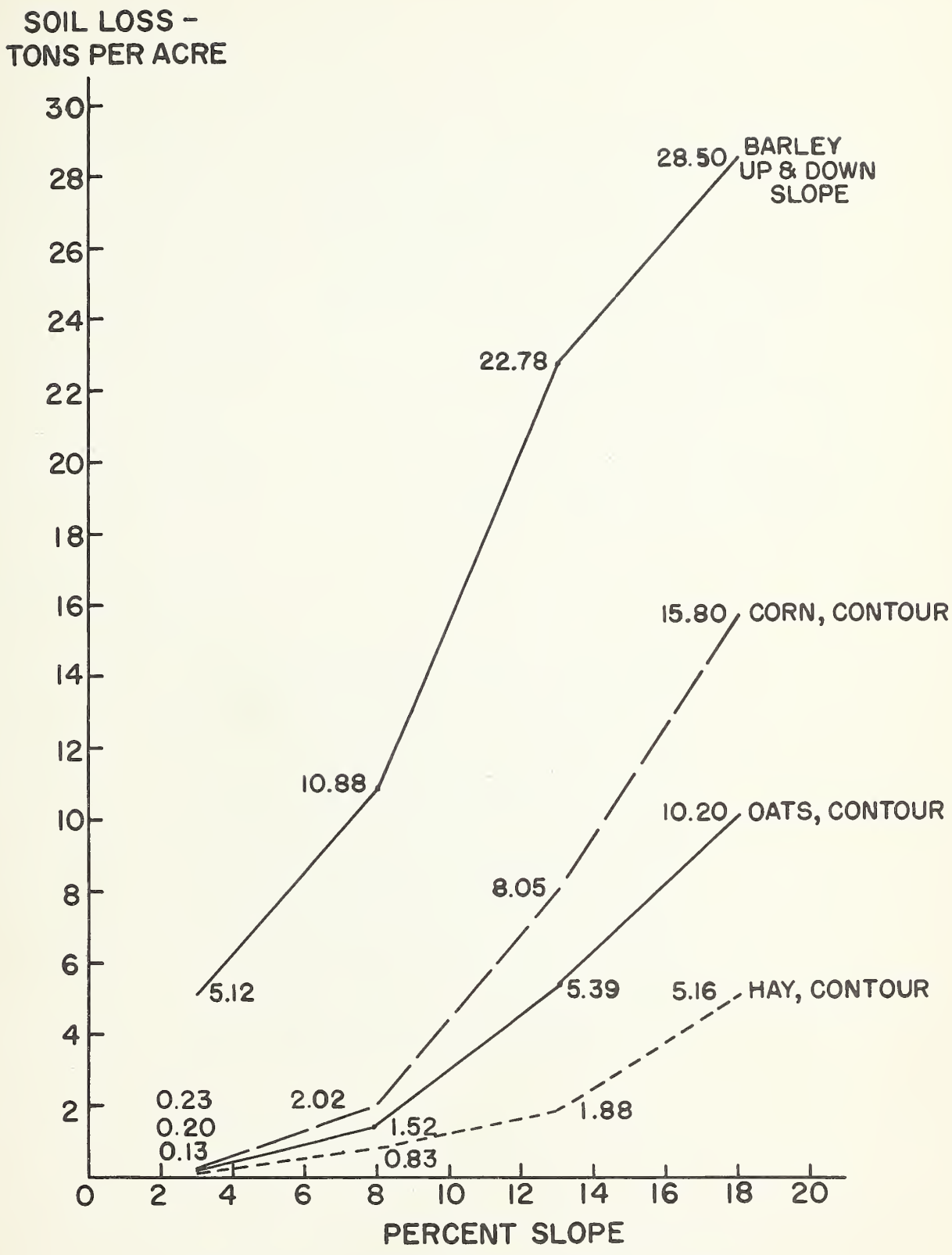


Figure 1.--Effect of slope (percent) on soil loss, LaCrosse, Wis., 1939-57.

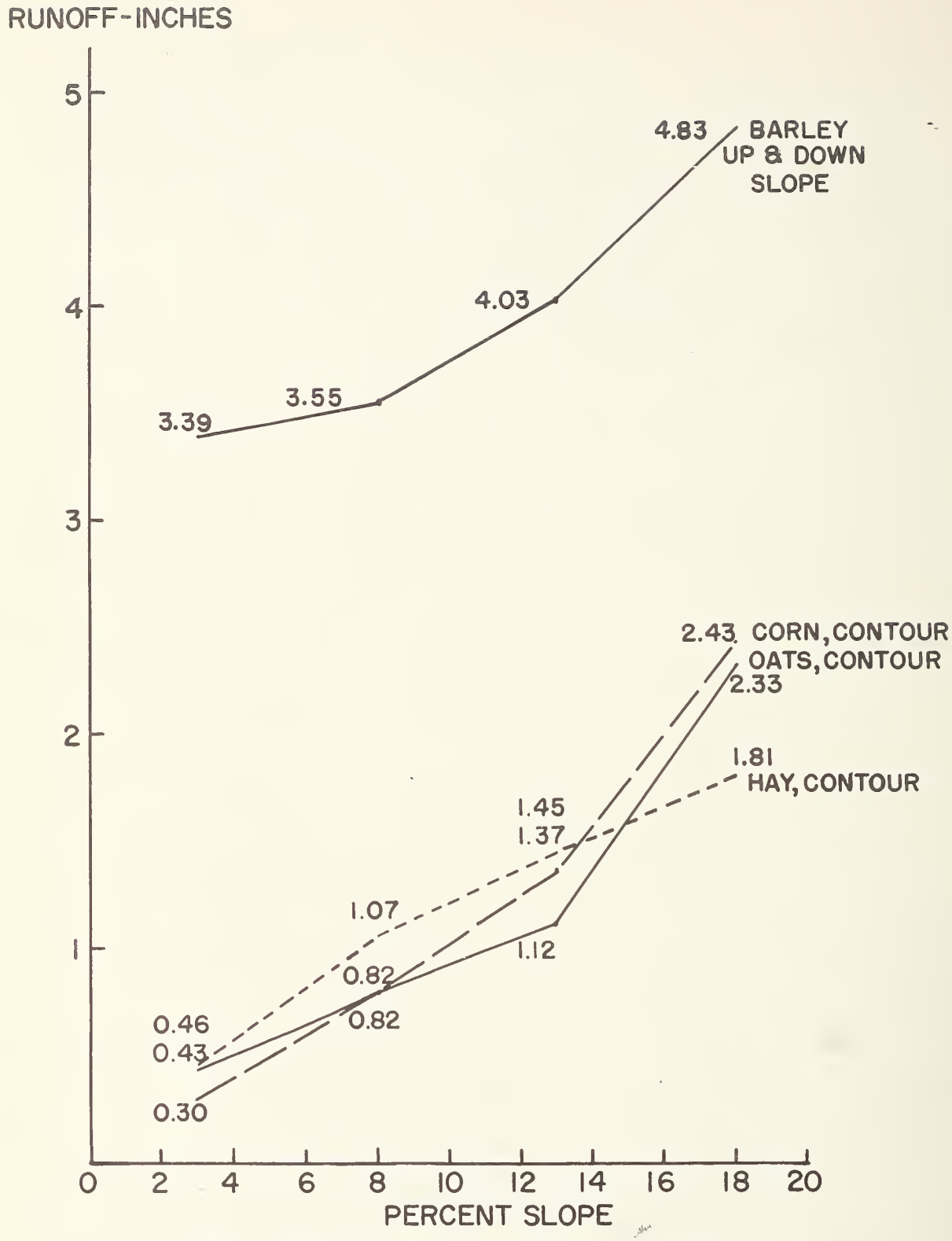


Figure 2. --Effect of slope (percent) on runoff, LaCrosse, Wis., 1939-57.

SPRING THAW OCCURS CONCURRENTLY WITH GULLY DEVELOPMENT

R. S. Palmer, Durham. --The disappearance of snow cover above a west-facing gully in the Connecticut River Valley at Claremont, New Hampshire, appeared to signal the breaking away of a 10-foot segment of the gully headwall.

This gully is underlain with bedrock, and piezometric measurements indicate that most water is carried off the field surface while the ground is frozen. With the melting of snow cover and the occurrence of spring rainfall, measured underground water levels increased to the north and south of the gullied area.

The additional runoff water increased stresses on the soil already weakened by seepage and resulted in the increased gully development, shown in the accompanying photos.

Figure 1. --Claremont gully, following snowmelt on April 1. Segmental breaking along short vertical planes renews erosion activity. Note the piezometer in right center background, Claremont, N. H., 1958

Figure 2. --Same gully on April 8. The dramatic breaking away of the headwall along vertical planes shows extent of mass soil movement. Note location of piezometer as compared to its relative position to headwall as seen in Figure 1, Claremont, N. H., 1958.

California

NITROGEN FERTILITY LEVEL OF COTTON DETERMINED BY TISSUE TEST

A. J. MacKenzie, Brawley. --The application of nitrogen fertilizer increased the yield of cotton on field experiments at the Southwestern Irrigation Experiment Station, Brawley, California, to a rather phenomenal extent. Tissue tests of the nitrate-nitrogen level of the cotton leaf petioles revealed the fertility status of the cotton plant at the time of sampling. Furthermore, this information would permit a surprisingly close prediction of the ultimate cotton yield under the conditions of the experiment.

Petioles of the uppermost fully expanded or most recently mature leaves on the main stem of the cotton plants were selected for sampling. The fresh petioles were chopped, dried at 65° C. and ground to pass a 20-mesh screen. A laboratory chemical analysis for water soluble nitrate-nitrogen was performed using the method of Johnson and Ulrich (Anal. Chem. 22, 1526, 1950).

The data shown in the accompanying table are typical of the results obtained in this study. The nitrate-nitrogen content of the petioles during the season were directly related to the rate of nitrogen applied, and the highest yield of cotton was obtained when the petiole nitrate-level remained at a relatively high level during the growing season.

For maximum yield of cotton under local growing conditions, this study indicates that the levels of petiole nitrate content should be high (12,000-16,000 p. p. m. nitrate-nitrogen) in late June and, then, gradually decline to approximately 2,000 p. p. m. by the end of July. Cotton crops which show a decline in petiole nitrate-nitrogen levels to 2,000 p. p. m. before the end of July can be sidedressed with nitrogen, and yield increases would be expected.

Effect of rate of nitrogen on the yield of cotton and the petiole nitrate-nitrogen content during the growing season, Brawley, Calif., 1956

Nitrogen per acre[2]	Yield per acre	NO_3 Nitrogen					
		Days after planting[1]					
		77	93	106	125	134	152
Pounds	*Bales*	*1,000 p.p.m.*	*1,000 p.p.m.*	*1,000 p.p.m.*	*1,000 p.p.m.*	*1,000 p.p.m.*	*1,000 p.p.m.*
0.....	1.85	1.09	0.16	0.03	0.01	0.02	0.00
60.....	2.64	2.19	0.45	0.28	0.01	0.02	0.02
120.....	3.19	9.47	1.01	0.74	0.09	0.07	0.09
180.....	3.84	13.36	3.42	1.37	0.72	0.27	0.42
240.....	3.91	14.58	5.12	2.57	1.02	0.23	0.69
300.....	4.20	18.00	10.75	8.09	3.18	1.26	1.18

[1] Planted and irrigated, April 11.
[2] 1/3 of total nitrogen applied preplant and remaining 2/3 applied June 6, 56 days after planting.

North Dakota

P FERTILIZATION INCREASES SOLUBLE P IN DENUDED SOILS

D. L. Grunes, G. A. Reichman, C. W. Carlson, and Joseph Alessi, Mandan. --In land leveling to facilitate gravity irrigation, it is frequently necessary to remove considerable surface soil from certain areas. The subsoil which is exposed is often considerably lower than the surface soil in available phosphorus. Parallel experiments were set up on an undisturbed area (table 1) and on an area from which a foot of surface soil was removed during the land leveling process (table 2). Crops grown were corn in 1954, potatoes in 1955, and corn again in 1956. This presentation deals with effects of

fertilization and cropping on the sodium bicarbonate soluble phosphorus in soil sampled from the 0-7 inch layer of these experiments.

In the undisturbed area, the original sodium bicarbonate soluble phosphorus was sufficiently high in 1954, so that no response to applied phosphorus fertilizer would be expected. Cropping has decreased the soluble phosphorus (treatments A and F). Phosphorus fertilization increased the soluble phosphorus measured in the spring of 1956 (treatments B and E). Phosphorus fertilization in the spring of 1956 has still further increased the soluble phosphorus measured that fall on these same two treatments. Manure was effective in increasing soluble phosphorus, the values still being high in the spring and fall of 1956 (treatment I). Highest values for soluble phosphorus were measured on plots fertilized with both phosphorus and manure (treatment L).

TABLE 1.--Sodium bicarbonate soluble phosphorus in the 0-7 inch layer from an undisturbed area, Upham, N. D.

Treatment	Fertilizer treatment per acre					$NaHCO_3$ soluble phosphorus		
	1954			1955	1956	Prior to planting and fertilization in the spring		After harvest
	$N-P_2O_5$	Zinc	Manure	$N-P_2O_5$	$N-P_2O_5$	1954	1956	1956
	Pounds	*Pounds*	*Tons*	*Pounds*	*Pounds*	*p.p.m.* [1]	*p.p.m.* [1]	*p.p.m.* [1]
A.....	0-0	0	0	180-0	120-0	10.4	8.0	6.0
B.....	0-100	15	0	180-0	120-100	10.4	12.7	18.5
E.....	180-100	15	0	180-0	120-100	10.4	11.8	18.9
F.....	180-0	15	0	180-0	120-0	10.4	7.0	6.4
I.....	0-0	0	20	180-0	120-0	10.4	14.8	12.7
L.....	180-100	15	20	180-0	120-100	10.4	18.6	26.1

[1] To change to pounds P_2O_5/acre, multiply by 4.58.

Olsen, Cole, Watanabe, and Dean in USDA Circular 939 set up the following limits for $NaHCO_3$ soluble phosphorus.

Below 5.46 -- p. p. m. P, a response.
5.46-10.90 p. p. m. P, probable response.
Above 10.90 -- p. p. m. P, response unlikely.
Values may need to be lower for corn and higher for potatoes.

On the cut area (table 2) cropping has not decreased the soluble phosphorus (treatments A and F). Phosphorus fertilization has increased the soluble phosphorus measured in the spring of 1956 (treatments B and E), and phosphorus fertilization that spring still further increased the soluble phosphorus measured that fall. Soluble phosphorus was slightly lower for treatment E than for treatment B, since higher yields obtained on these nitrogen fertilized plots in 1954, undoubtedly, removed more phosphorus. Values for soluble soil phosphorus were higher when the 1954 rate of P_2O_5 application was doubled (compare treatment E and G).

The soluble phosphorus content in the spring of 1956 was higher on those plots manured in 1954 than when phosphorus fertilizer had been applied in 1954 (compare treatments B, E, G, and I, table 2).

For the 40 ton per acre manure application, values for soluble phosphorus were considerably higher than for the 20 ton per acre application in both the spring and fall of 1956 (compare treatments I and J). Values for soluble phosphorus were considerably above plant requirements, following the addition of both phosphorus fertilizer and manure (treatment L).

TABLE 2.--Sodium bicarbonate soluble phosphorus in the 0-7 inch layer from an area with surface soil removed, Upham, N. D.

Treatment	Fertilizer treatment per acre					$NaHCO_3$ soluble phosphorus		
	1954			1955	1956	Prior to planting and fertilization in the spring		After harvest
	$N-P_2O_5$	Zinc	Manure	$N-P_2O_5$	$N-P_2O_5$	1954	1956	1956
	Pounds	*Pounds*	*Tons*	*Pounds*	*Pounds*	*p.p.m.*	*p.p.m.*	*p.p.m.*
A.....	0-0	0	0	180-0	120-0	3.2	4.2	3.7
B.....	0-100	15	0	180-0	120-100	3.2	6.0	14.9
E.....	180-100	15	0	180-0	120-100	3.2	4.8	11.0
F.....	180-0	15	0	180-0	120-0	3.2	3.2	3.2
G.....	180-200	15	0	180-0	120-100	3.2	9.7	15.9
I.....	0-0	0	20	180-0	120-0	3.2	11.3	7.8
J.....	0-0	0	40	180-0	120-0	3.2	22.1	14.0
L.....	180-100	15	20	180-0	120-100	3.2	15.6	20.6

Washington

PAST CROPPING AND FERTILIZER HISTORY AFFECT RESIDUAL NITROGEN

Louis C. Boawn, Prosser.--Fairly precise nitrogen fertilizer recommendations can be made for a given crop, if the past cropping history and nitrogen application rate for the field to be planted is known.

This conclusion is drawn from field plot studies conducted on the Roza Unit of the Washington Irrigation Experiment Station at Prosser during the period 1955-57.

For the first year, 1955, large plots were treated with 0, 40, 80, 120, and 200 pounds of N per acre. Two series of plots were established, one on virgin land, and another on an adjacent field which had been in alfalfa three years. About 4 inches of spring growth of alfalfa was plowed down. Corn was grown on the plots and the uptake of nitrogen determined.

In 1956, each of the main plots treated in 1955 were divided into 6 subplots for nitrogen rates of 0, 40, 80, 120, 200, and 400 pounds per acre. Again, corn was grown and the uptake of nitrogen determined.

In 1957, no nitrogen was applied, the objective being to evaluate the residual nitrogen resulting from previous fertilizer applications and past cropping history.

Figures 1 and 2 show the effect of 1955 and 1956 nitrogen rates on the residual nitrogen available to corn grown on the plots in 1957. On ground which was virgin in 1955, the 1955 nitrogen rate had no effect on the amount of residual nitrogen available to corn in 1957. On the alfalfa ground, however, the amount of nitrogen applied in 1955 did influence the 1957 residual nitrogen. In general, the amount of residual nitrogen in 1957 increased 0.2 pound for each pound of nitrogen applied in 1955. This relationship was not affected by the amount of nitrogen applied in 1956.

On both the virgin ground and alfalfa ground, the rate of nitrogen in 1956 influenced the 1957 residual nitrogen. On virgin ground, the effect was linear throughout the range of nitrogen application, amounting to about 0.28 pound nitrogen for each pound of nitrogen applied in 1956. The influence of the 1956 nitrogen rate on alfalfa ground was similar, except that no increase in residual nitrogen uptake occurred when the 1956 nitrogen

application was greater than 200 pounds per acre. Apparently, this occurred, because the amount of nitrogen available was excessive to the needs of the corn.

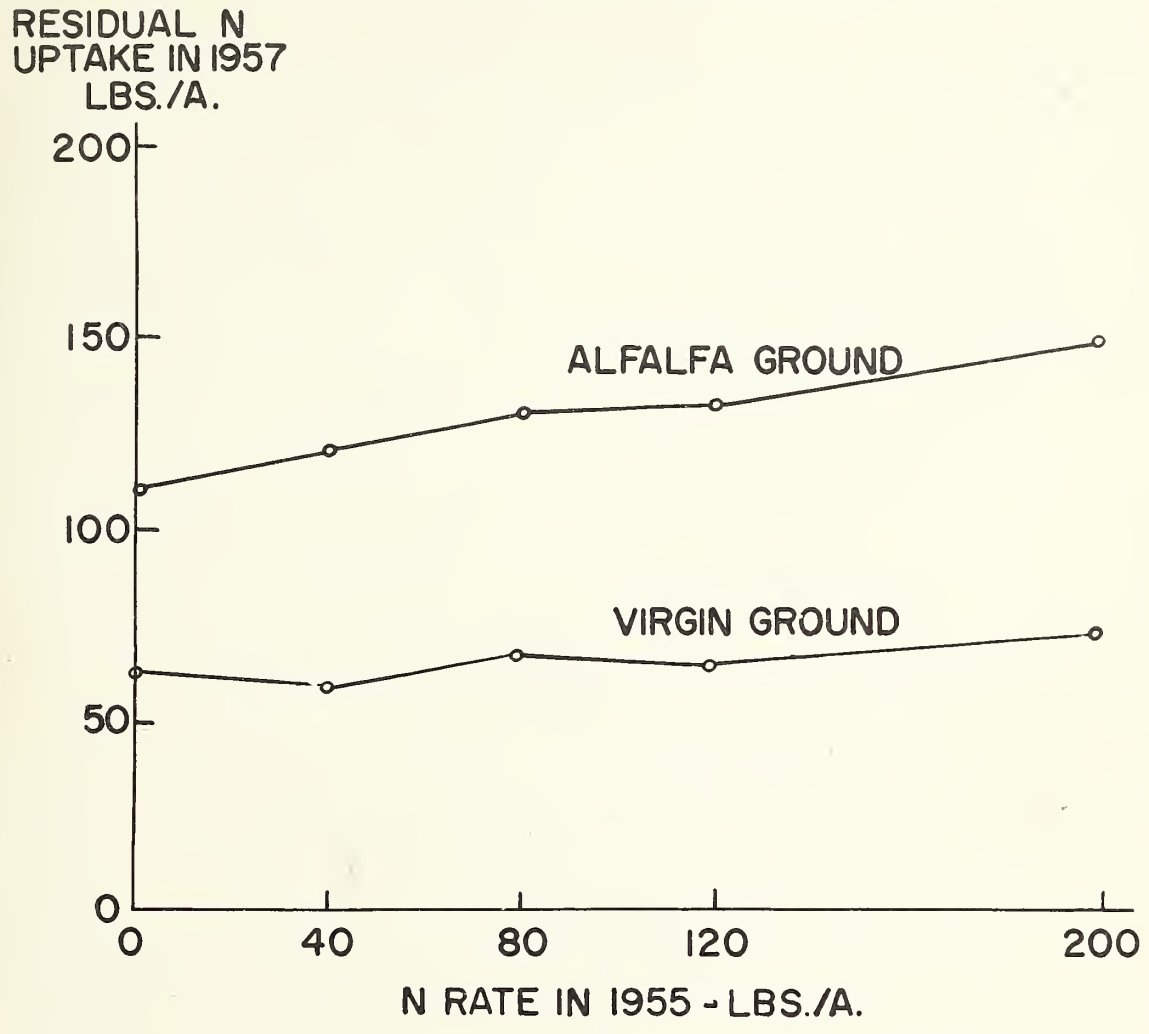


Figure 1.--Nitrogen uptake by corn in 1957 as a function of the amount of nitrogen applied in 1955, Prosser, Wash.

Fairly precise nitrogen fertilizer recommendations could be formulated for these specific cropping systems.

For third year corn on virgin ground:

Fertilizer N needed = crop requirement - (0 x 1st Yr. N Rate)
-(0.28 x 2nd Yr. N Rate) -27.2

For third year corn on old alfalfa ground:

Fertilizer N needed = crop requirement -(0.2 x 1st Yr. N Rate)
-(0.28 x 2nd Yr. N Rate*) -69.2

*Up to 200 pounds nitrogen per acre.

The values 27.2 and 69.2 in these equations are the amount of nitrogen taken up from the check plots. The crop requirement is the total nitrogen in all above-ground portions of the plant at maturity.

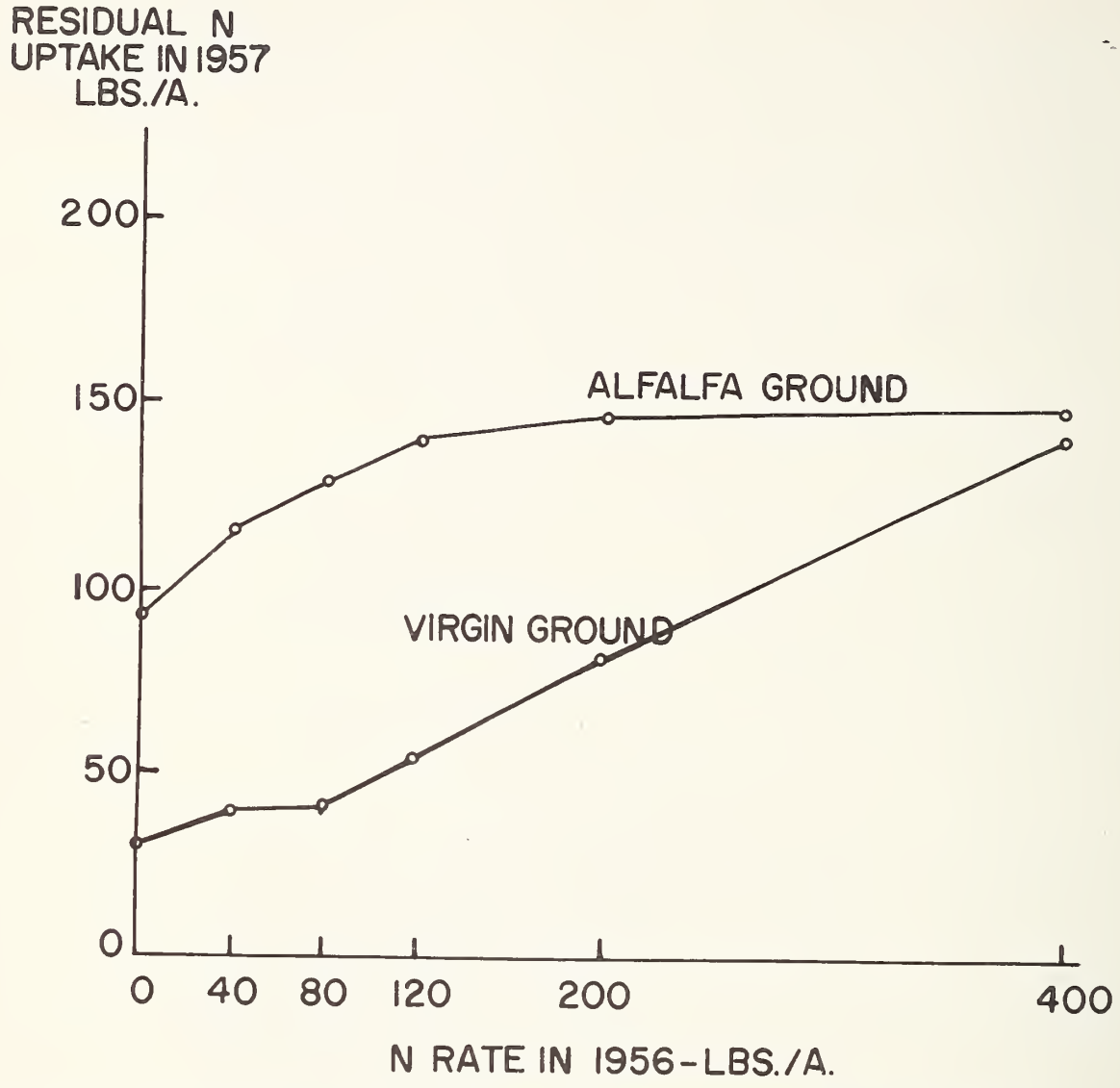


Figure 2.--Nitrogen uptake by corn in 1957 as a function of the amount of nitrogen applied in 1956, Prosser, Wash.

Texas

FERTILIZER HAD NO EFFECT ON DRYLAND WHEAT YIELDS

Harold V. Eck and Carl Fanning, Bushland.--The use of nitrogen and phosphorus fertilizers did not affect yields of dryland winter wheat grown on Pullman silty clay loam soil in 1958. Grain yields for the various fertilizer treatments are presented in the accompanying table.

The fertilizer treatments have been superimposed on the long time stubble-mulch experiment at Bushland. They are being studied under three methods of tillage (one-way plowed, subsurface tilled with 30-inch sweeps, and subsurface tilled with 8-inch Graham

Hoeme sweeps) and two cropping systems (continuous cropping and alternate crop and fallow).

Surface residue management such as that obtained by subsurface tillage is a positive practice from the standpoint of wind and water erosion control. However, occasional yield depressions are experienced under surface residue management tillage. The fertilizer treatments are being studied as means for alleviating these yield depressions.

Drought conditions during 1954, 1955, and 1956 wiped out differentials in surface residue and soil moisture on the tillage and cropping system treatments, thus the yields reported here are average over the soil treatments.

With the residue produced and the soil moisture differentials established by the 1958 crop between continuously cropped and alternately cropped and fallowed plots, it will be possible to study the effects of fertilizer under the various systems of management in the 1958-59 season.

Yields of dryland winter wheat under various fertilizer treatments, Bushland, Texas, 1958

Fertilizer per acre N - P_2O_5	Wheat yields per acre
Pounds	*Bushels*
0 - 0	14.7
10 - 0	14.0
20 - 0	14.3
40 - 0	14.1
0 - 40	14.1
10 - 40	13.8
20 - 40	13.6
40 - 40	14.0

Maryland

N UPTAKE INFLUENCED LITTLE BY NH_4-FIXING CAPACITY OF SOILS

J. O. Legg and F. E. Allison, Beltsville.--Certain clay minerals in soils, especially vermiculite, montmorillonite, and degraded illite, are known to fix ammonium within the clay lattice structure in such a way that it is not removed by leaching with a KCl solution and is only slowly removed by leaching with other salt or dilute acid solutions such as $CaCl_2$, NaCl, or HCl. Most surface soils fix only small amounts of ammonium, but subsoils may fix the equivalent of 4,000 pounds or more of nitrogen per acre under laboratory conditions. The amount of ammonium fixed is generally increased by drying. When the fixation capacity of such subsoils has been completely filled, the availability of the fixed ammonium to microorganisms and plants is usually in the order of 10 to 30 percent.

A greenhouse experiment was carried out to determine the availability of ordinary field applications of nitrogen, ranging from 25 to 400 pounds per acre, applied to both ammonium-fixing and non-fixing soils. Sources of nitrogen were $(NH_4)_2SO_4$ and $NaNO_3$ which were tagged with N-15 to permit a more accurate measure of fertilizer nitrogen uptake than ordinary methods allow. With the exception of the band placement, the $(NH_4)_2SO_4$ was mixed throughout the soil. One set of treatments was moistened and air-dried before planting the Sudangrass. The capacity of the Myersville subsoil to fix ammonium, in terms of pounds of nitrogen per acre, was 1,142 for moist and 1,705 pounds for air-dried conditions. The respective values for the Miami subsoil were 154 and 330. A nonfixing Cecil surface soil was used for comparative purposes.

The accompanying table shows only small differences between the two ammonium-fixing soils in uptake of fertilizer nitrogen by Sudangrass. The effect of air-drying was greatest at the low nitrogen levels. The tabular values show that there was essentially no difference in nitrogen uptake between the ammonium-fixing soils and the nonfixing-surface soil. This may be attributed in part to the greater biological fixation in the Cecil soil; nevertheless, the results indicate rather high plant availability of ammonium applied at ordinary field rates to the ammonium-fixing soils. Band placement of ammonium, or the use of nitrate-nitrogen, generally increased both yields and nitrogen uptake over those obtained with ammonium mixed throughout the soil. There was little loss of nitrogen by denitrification, or other means, in this experiment as indicated by an overall recovery value of 94 percent of the tagged fertilizer from the soil and plant materials.

Recovery of applied nitrogen in Sudangrass, including roots, Beltsville, Md.

Soil and treatment	Nitrogen recovered				
	Nitrogen rate (pounds per acre)				
	25	50	100	200	400
Myersville subsoil	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
NH_4 - moist	43	53	58	68	76
NH_4 - air dried	32	43	60	66	77
NH_4 - band		74		78	
NO_3		69		81	
Miami subsoil					
NH_4 - moist	50	59	60	63	68
NH_4 - air dried	31	44	55	60	62
NH_4 - band		67		72	
NO_3		68		71	
Cecil surface soil					
NH_4 - moist		52		64	

Georgia

COMMON BERMUDA IS EQUAL TO COASTAL BERMUDA IN NPK

William E. Adams, Athens.--When grown on Cecil sandy loam soil with crimson clover, common Bermuda is at least equal to Coastal Bermuda, in content of nitrogen, phosphorus, and potassium. Coastal Bermuda absorbed in the plant, or removed from the soil, more pounds per acre of nitrogen, phosphorus, and potassium than common Bermuda. The difference in nutrient uptake between the two Bermudas is a forage production difference.

The percentage and uptake of nitrogen, phosphorus, and potassium for both Coastal and common Bermuda when grown in association with crimson clover for 1956 are shown in the following table.

The uptake of all nutrients studied was greater with increased fertilizer levels.

Soil studies indicated that soil phosphorus was being maintained at an adequate level where fertilizer with a 2-1-1 (N-P_2O_5-K_2O) ratio was applied. At each fertilizer level, the K_2O removed by the Coastal Bermuda and the crimson clover was about double the K_2O applied.

Treatment	Plant composition and nutrient removal per acre					
	Nitrogen		Phosphorus		Potassium	
N-P_2O_5-K_2O per acre	Composition	Removal	Composition	Removal	Composition	Removal
	Coastal Bermuda with crimson clover					
Pounds	*Percent*	*Pounds*	*Percent*	*Pounds*	*Percent*	*Pounds*
0-0-0.....	1.58	9.2	0.199	10.8	1.09	44.8
50-50-50.....	1.61	16.8	0.218	31.60	1.09	86.4
100-50-50.....	1.75	22.4	0.210	41.2	1.09	110.1
200-50-50.....	2.11	32.1	0.217	52.4	1.08	127.2
200-100-100.....	2.02	42.5	0.244	61.6	1.20	160.6
400-100-100.....	2.38	57.6	0.243	71.3	1.41	213.7
400-200-200.....	2.28	76.0	0.252	84.4	1.73	316.0
	Common Bermuda with crimson clover					
0-0-0.....	1.64	6.0	0.212	13.46	1.19	39.6
50-50-50.....	1.73	8.0	0.243	23.43	1.35	68.7
100-50-50.....	1.82	11.6	0.229	31.94	1.19	88.8
200-50-50.....	2.05	16.4	0.221	40.42	1.21	114.7
200-100-100.....	2.12	20.6	0.237	44.38	1.52	149.6
400-100-100.....	2.21	20.9	0.236	49.19	1.53	166.0
400-200-200.....	2.28	32.9	0.258	58.26	1.90	227.3

The pH and soil K_2O were reduced as nitrogen rates were increased, which reduced the forage production of crimson clover. New experiments are being initiated to study methods of preventing this increase in soil acidity and depletion of soil potassium.

Puerto Rico

QUALITY OF GRASSES DECREASES WITH LONGER HARVEST INTERVAL

Jacinto Figarella and Servando Silva, Rio Piedras. --The protein, calcium, phosphorus, potassium, and magnesium content of Napier, Guinea and Para grasses decreased, while lignin content increased as interval between cuttings was lengthened.

The data in the table show the effect of length of harvest interval on the composition of these three grasses. All grasses received 800 pounds N, 300 pounds P_2O_5, and 600 pounds K_2O per acre, yearly, in 6 equal applications.

The protein, calcium, phosphorus, and magnesium content of the forages decreased with length of harvest interval. These nutrients are important in animal nutrition. The changes in potassium content are of little significance, since this element is not important to animals. On the other hand, the increase in lignin content with harvest interval is important, since digestibility decreased with increasing lignin content.

The effect of length of harvest interval on the composition of three tropical grasses grown with close to optimum fertilization, Rio Piedras, P. R.

Harvest interval	Dry matter per acre yearly	Composition on a dry weight basis					
		Ca	P	K	Mg	Protein	Lignin
			Napier grass				
Days	*Pounds*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
40.....	24,520	0.35	0.32	1.87	0.35	13.6	7.9
60.....	44,561	0.27	0.27	1.25	0.27	9.9	9.4
90.....	75,661	0.22	0.19	0.70	0.22	7.3	11.6
			Guinea grass				
40.....	27,552	0.98	0.24	2.21	0.47	10.3	8.4
60.....	32,733	0.81	0.19	1.70	0.46	8.9	10.6
90.....	43,608	0.65	0.15	0.82	0.40	6.7	11.8
			Para grass				
40.....	23,607	0.44	0.19	1.84	0.34	11.7	8.2
60.....	30,841	0.39	0.17	1.70	0.25	9.5	8.9
90.....	36,294	0.34	0.14	1.40	0.23	7.2	9.8

Puerto Rico

HIGH YIELDING GRASSES REMOVE LARGE AMOUNTS OF NUTRIENTS

Jose Vicente-Chandler and Ruben Caro, Rio Piedras.--High-yielding tropical Napier, Guinea and Para grasses remove tremendous amounts of nutrients, particularly nitrogen and potash, from the soil.

The data in the accompanying table show the pounds of nutrients contained in the forage produced per acre, yearly, by various grasses growing on a Fajardo clay soil with close to optimum fertilization.

Ingredient	Ingredients removed per acre annually		
	Napier grass	Guinea grass	Para grass
	Pounds	*Pounds*	*Pounds*
Dry matter..	37,121	35,843	22,665
N.....	683	609	440
P_2O_5.....	135	114	88
K_2O.....	581	432	518
Ca.....	219	262	125
Mg.....	108	129	43

These data indicate the need for heavy applications of fertilizer, particularly nitrogen and potash, to these forages, if high yields are to be maintained.

California

NEW METHOD DEVELOPED TO DETERMINE SURFACE AREA OF SOILS

C. A. Bower and J. O. Goertzen, Riverside.--The ethylene glycol retention method developed by Dyal and Hendricks for measuring the surface areas of clays has been widely used and has given much useful information. It is a nonequilibrium method, however, and the endpoint corresponding to a monolayer of glycol on particle surfaces is indistinct.

An improved ethylene glycol method for use on soils or clays has been devised. The soil or clay sample after being dried over P_2O_5 and wetted with excess glycol is equilibrated in vacuum at 25° C. over a mixture of anhydrous $CaCl_2$ and its glycol solvate. Mixtures of anhydrous $CaCl_2$ and its glycol solvate in all proportions have a vapor pressure of glycol at 25° C. which results in adsorption or retention of approximately a monolayer of the compound on soil surfaces. As shown by the accompanying table, surface area values for soils and clays by the equilibrium method agree well with those obtained by careful use of the nonequilibrium method.

Comparison of total surface area determinations of soil or clay by equilibrium and nonequilibrium methods, U. S. Salinity Laboratory, Riverside, Calif.

Soil or clay	Total surface area	
	Equilibrium method	Nonequilibrium method
	Sq. m./gm	*Sq. m/gm*
Panther Creek, Miss. bentonite	822	815
Dry Branch, Ga. kaolin	20	25
Sebree clay loam	171	183
Billings silt loam	45	42
Aiken clay loam	104	107
Wyoming bentonite	822	842

MOISTURE CONSERVATION

Maryland

WHITE PLASTIC GROUND COVER INSURES GRASS ESTABLISHMENT

C. S. Slater and R. VD. Broach, Beltsville.--A Kentucky 31 fescue seeding covered with white polyethylene film of 4 mils thickness produced a satisfactory stand of grass in 90° F. heat in July 1958.

The planting was made June 30 on raw subsoil that had been plowed, disked, and fertilized with 1,000 pounds per acre of 10-10-10- broadcast and raked in. The fescue was broadcast at 65 pounds per acre. The soil was dry at the surface and after seeding the plot was given a 0,2 inch irrigation.

The following week was hot and generally clear with afternoon temperatures each day above 90° F. Examination on July 7 showed a good stand of grass seedlings under the film. At this time, the soil appeared drenched with moisture. No grass seedlings were evident on this date on a check plot that had been mulched with hay.

High humidity and condensation maintained the water supply under the film and did not appear harmful. Fescue planted on May 29 and kept continuously under the plastic maintained good growth without evidence of disease to date (July 10), although more succulent than when grown in the open. Fescue planted under white plastic on May 29 and uncovered June 25 in bright sun and an air temperature of 85° F. did not scald and has continued good growth.

Fescue planted under clear plastic on May 29 failed to germinate, and miscellaneous vegetation that volunteered was all dead by July 10.

Afternoon temperatures under the plastic films for 90° F.-sunny weather are given in the accompanying table. The temperatures under the white 4 mil plastic film are slightly higher, relatively, than similar data taken last year under white film 1-1/2 mils in thickness.

Soil and air temperatures in the open air and under white and clear plastic for 90° F.-sunny weather, Beltsville, Md., 1958

Location	Temperature		
	In open	Under white film	Under clear film
	°F	°F	°F
Air.....	90	99	119
Soil at 2 inches depth.	89	92	119

Kansas

FLOATING LYSIMETERS MEASURE EVAPORATION FROM SOIL

R. J. Hanks and S. A. Bowers, Manhattan.--Four floating lysimeters have been installed to study evaporation of water from soil. The lysimeter assembly shown in figure 1 consists of an inner tank containing soil, an outer tank containing water, and a stilling well. The inner tanks are 5 feet in diameter by 6 feet deep. The outer tanks are 4 inches larger in all dimensions. Changes in weight of the inner tank (soil) cause it to float higher or lower causing changes in the water level in the outer tank and stilling well. By measuring these changes in water level, evaporation (or precipitation) can be determined. Continuous measurements are made by recording the water level changes with a water level recorder. The inner tank containing soil is partially filled with "Stryofoam" to allow the tank to float. The density of the "Stryofoam" is about 1.5 pounds per cubic foot. The lysimeter is a modification of a Wisconsin design reported by King, Tanner, and Suomi (Transactions American Geophysical Union 37: 738). A view of the field installation is shown in figure 2.

Figure 3 is a reproduction of an actual chart for May 16 to May 21 showing water level changes. The 0.50 inch rain that occurred May 16 about 9:00 p. m. is shown. Very little evaporation took place until 8:00 a. m., May 17. From 8:00 a. m. to 6:00 p. m., 0.18 inch of water was evaporated. The soil surface was dry by about 4:00 p. m. The evaporation from then on was nearly constant and amounted to 0.17 inch at the end of May 21 or was about 0.04 inch per day.

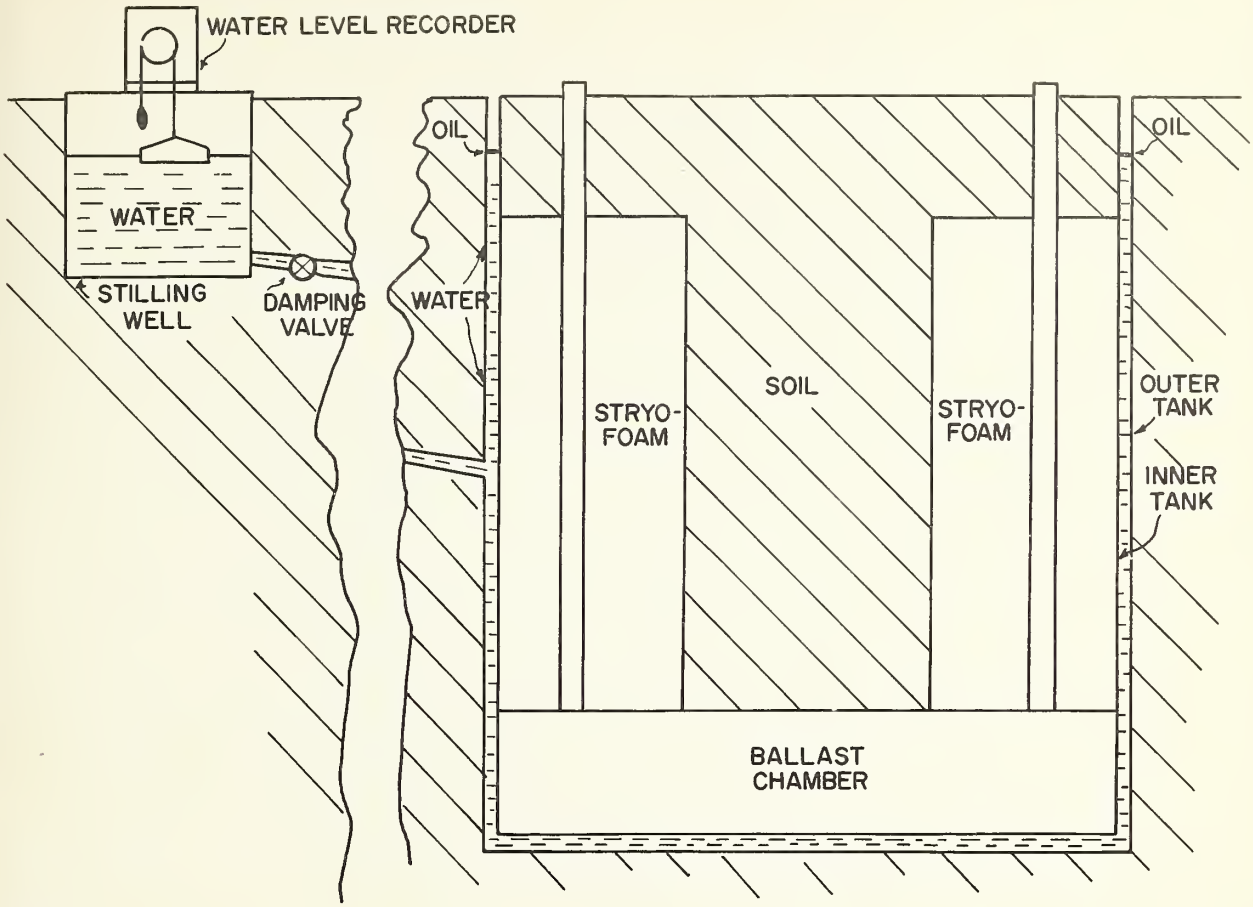


Figure 1. --Sketch of floating lysimeter assembly. Lysimeters are used to study the influence of soil surface conditions on evaporation, Manhattan, Kan.

Figure 2. --Two floating lysimeters used to study the influence of soil surface conditions on evaporation, Manhattan, Kan.

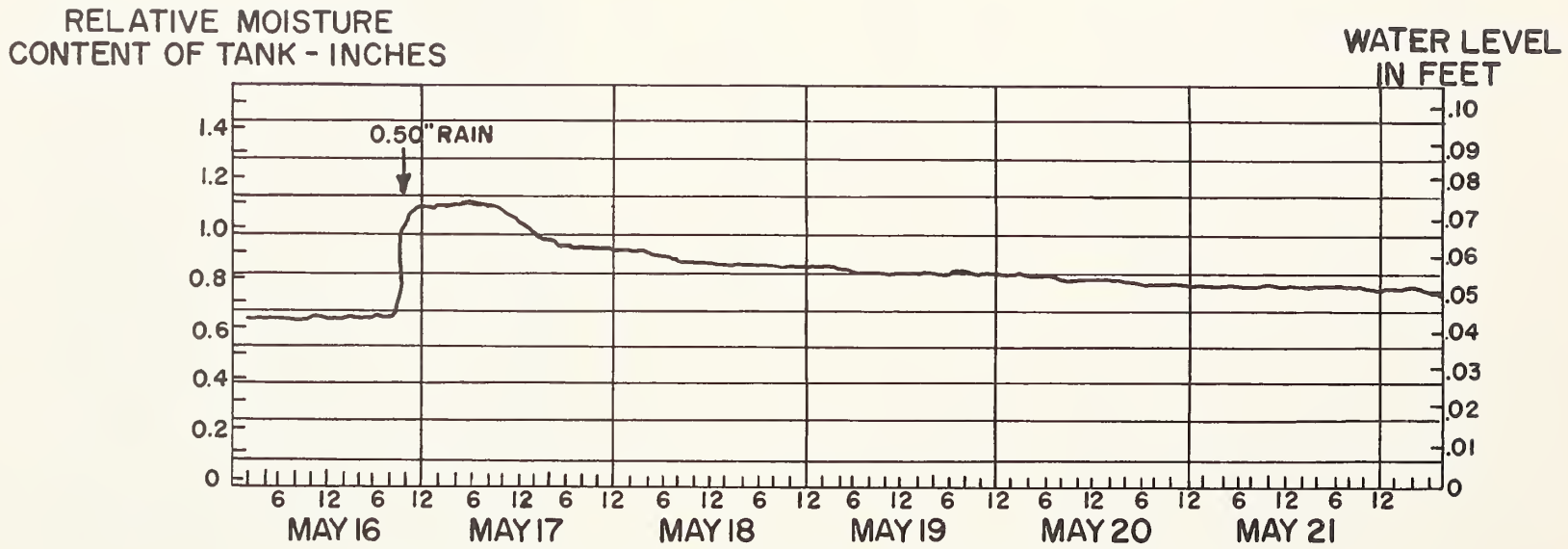


Figure 3. --Tracing of water level recorder chart from floating lysimeter, Manhattan, Kan.

New York

BLACK PLASTIC MULCH USED AS RESEARCH TOOL FOR CORN

G. R. Free, Ithaca. --A uniform straw-mulch experiment was started in 1957 in New York, as well as in States in the Southeast, Northeast, and Middle-West in order to get a basic understanding of the effects of mulch resulting from stubble-mulch tillage on corn growth and yields.

In the New York experiment, three tons per acre of straw were plowed under for corn, while on other plots, the same amount was applied as a mulch after planting. Treatments included medium and high levels of nitrogen fertilization. Data, including measurements of growth and yields of corn, soil temperature, soil moisture, and nutrient uptake will be obtained over a period of three or four years at the various locations which represent a wide range of soil and climatic conditions.

Since a straw mulch depresses soil temperature, a black platic mulch, which will increase soil temperature, was added in the experiment at Marcellus, New York. This black plastic mulch was tried only at the high-level N treatment.

Results in 1957 for the high-level N treatments only are given in the accompanying table. Corn heights by the end of July under the black plastic treatment were about 30 percent higher than under the next-best treatment. The rate of growth and final yields were higher than those in any other experiment at the project.

Treatment	Corn yield per acre	Dry matter in corn ears
	Bushels	*Percent*
Black plastic mulch.....	130	68
Straw plowed under.....	117	67
Straw mulch.....	99	57

Soil temperatures were higher under the black plastic than under the plowed-under treatment, which, in turn, were higher than under the straw mulch. The effect of the black plastic was most marked on cool, sunny days, but higher temperatures prevailed through the nights, also.

Early data for 1958 show similar patterns of effects on soil temperatures and growth. In 1958, however, the whole growth level to the end of June was suppressed by record low mean temperatures for the month. The mean was only 58.8° F., which is more than 5° below normal. With planting dates about the same in 1958 as in 1957, corn heights by the end of June were less than half those in 1957. June temperatures were above normal in 1957.

Another benefit of the black plastic mulch is that no cultivation or spray for weed control is necessary. Whether there is a place for this practice, or some modification of it, in corn production in the Northeast on a field basis remains to be determined. The results thus far seem to place considerable emphasis on factors affecting soil temperatures.

MINIMUM SEEDBED PREPARATION FOR CORN IS ENCOURAGING

J. Nick Jones, Jr., J. H. Lillard and J. E. Moody, Blacksburg. --The effect of minimum tillage on the stand and yield of corn under several types of crop and residue management were studied during the period 1955-1957. The experiment was located on Greendale silt loam soil with slopes up to 3 percent and erosion varying from slight to moderate. Total rainfall for the April-September growing season was 12.52 inches in 1955, 22.58 inches in 1956, and 24.48 inches in 1957. Distribution of rainfall varied widely from year to year; however, deficiencies occurred each year in May, July, and August.

With all plots planted at a uniform rate the minimum tillage treatments averaged 12,501 stalks per acre and 68.2 bushels per acre. The conventional treatments averaged 14,006 stalks per acre and 70.1 bushels per acre. The reduction in stand on the minimum tillage plots probably accounted for the lower average yields.

Each treatment used in the study is described in the accompanying table, along with yield and stand density.

Effect of tillage on corn stand and yield under various crop and residue managements. Average of 3-year results, Blacksburg, Va.

Crop treatment	Yield and stand per acre			
	Minimum tillage[1]		Conventional seedbed[2]	
	Yield	Stand	Yield	Stand
	Bushels	*Stalks*	*Bushels*	*Stalks*
Corn removed for silage and rye seeded early.....	68.6	13,375	68.1	13,978
Corn picked for grain, stover left, rye seeded late.....	66.2	12,347	68.2	13,497
Corn picked for grain, stover left.....	70.0	11,781	74.0	14,544
Average.....	68.2	12,501	70.1	14,006

[1] Consisted of turnplowing followed immediately by planting in tractor tracks.
[2] Consisted of turnplowing, two diskings and planting.

The late plowing required for the minimum tillage treatments usually resulted in an extremely rough seedbed on this moderately fine textured soil because of crop growth and moisture conditions at that period. Lower germination was a natural result.

The success of minimum tillage seems to depend on complete turning of the plow layer and the proper soil moisture content at plow-plant time. Since these conditions are more difficult to attain on sloping, fine textured soils with perennial grass sods, it appears that the minimum tillage practice will have greater application in central and eastern Virginia, where the topography is smoother and the soils are generally coarser textured.

Kansas

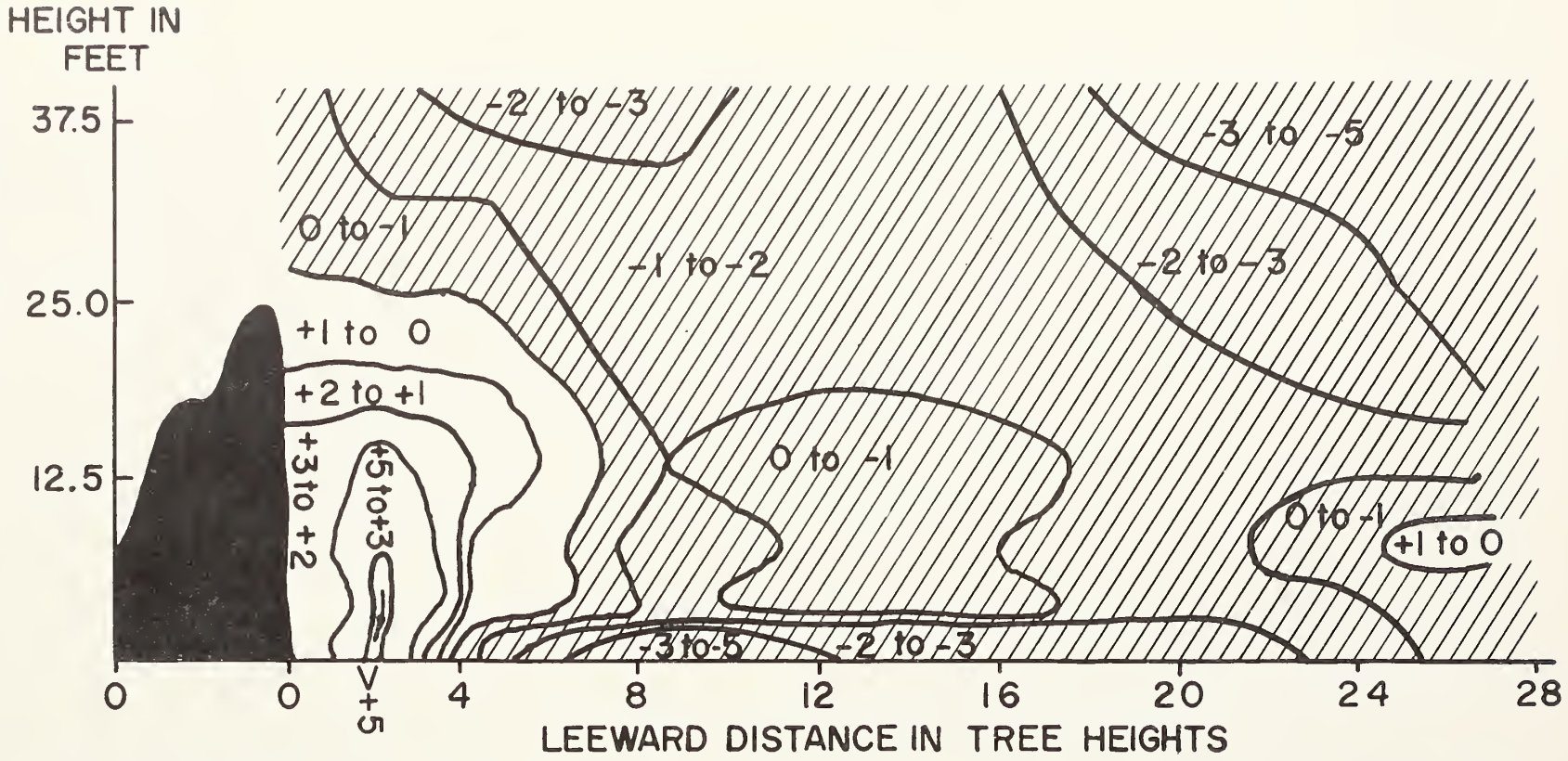
AIR TEMPERATURES ARE INFLUENCED BY FIELD WINDBREAKS

N. P. Woodruff, R. A. Read,[1] and W. S. Chepil, Manhattan. --Recent studies of the effects of field windbreaks on summer air temperatures have shown that air temperatures within the leeward zone of influence of a field windbreak are hotter in some places and cooler in others than in the open field.

The measurements showed that air temperature differences between leeward and open field varied with the degree of natural atmospheric turbulence at different times of the day or night. Temperature patterns were found to be similar within each of the following time-of-day groups: (1) Early morning and late afternoon--8:00 a. m. to 11:00 a. m. and 3:30 p. m. to 6:30 p. m., (2) midday--11:00 a. m. to 3:30 p. m. and (3) night--9:30 p. m. to 11:30 p. m. An example of temperature patterns obtained to the leeward during the midday period is shown in the accompanying figure.

Air temperature patterns to leeward of the windbreak were also closely related to the eddy zone produced by the barrier. Both hotter and cooler air was found on the leeward side. Warm zones were located close to the ground and near the trees where eddy currents were predominately rising. During the day, they extended leeward 5 to 10 times the height of the trees. At night a thin layer of air, 2 or 3 feet deep extending to about 26 H to the lee of the trees, and a thin vertical zone immediately in the lee were warmer than corresponding strata in the open. All other locations within the limits of measurement were cooler than open air for both day and night. The maximum measured temperature increase in the lee was 11° F. The average increase in the warmest places was from 2.7° F. at night and 6.9° F. during the early a. m. and late p. m. period. The average decrease in the coolest places ranged from 2.9° F. in the early a. m. period and late p. m. period to 6.2° F. during the midday period.

[1] Research forester, Forest Service, U. S. D. A., Lincoln, Nebraska.



Temperature differences between the open field and leeward of a windbreak at midday. Shaded areas indicate cooler than open-field air; clear areas indicate warmer than open-field air, Manhattan, Kan.

Georgia

UTAH SOIL SAMPLER USED FOR GRASS ROOT STUDIES

Charles B. Elkins, Athens.--A Utah (Kelly) soil sampler was used to take root samples of fescue, bahia, common Bermuda, and Coastal Bermudagrass. Each sample consisted of a core four inches in diameter and about six feet deep. The cores were placed on a hardware cloth rack, and the soil was removed from the roots by gentle agitation in a tank of water. The roots were then transferred to a board, and, when dry, they were treated with plastic to protect and hold them to the board. The root samples are shown in the accompanying figure along with a monolith of the Cecil sandy loam soil in which the plants were growing. All four samples were taken from grass stands that were approximately two years old.

Four other cores, two of common and two of Coastal Bermuda, were cut into 6- and 12-inch segments prior to washing. The roots from each segment were ovendried and weighed. On the basis of these weights, there was an indication that common Bermuda roots developed to a greater extent near the surface, while Coastal Bermuda produced more roots at greater depths. There seems to be little difference in the total weight of roots developed by the two grasses.

The Utah soil sampler seems to be well suited for studying the roots of plants with fibrous root systems. This work was of exploratory nature, and plans have been made to do further work on root penetration and development as affected by physical and chemical properties of the soil.

Virginia

EFFECT OF NA ON BEANS DETERMINED BY SOIL AND BASE SATURATION

J. Lunin and M. H. Gallatin, Norfolk.--Utilization of brackish water will invariably result in a certain amount of adsorption of sodium by the soil. Ion exchange theory states that the degree of adsorption of an added ion by the soil will be greatly affected by the nature of the adsorbed cations already present in the soil. The relative proportions of adsorbed cations in the soil may affect both yield and chemical composition of the plant grown. Since acid soils of the humid region vary greatly with respect to degree of calcium saturation, it was desirable to determine the interaction between base saturation and adsorbed sodium on the growth of plants.

A greenhouse experiment was planned, in which 3 soils were treated with sodium bicarbonate and calcium carbonate to give 3 levels of base saturation (approx. 50, 75, and 100 percent) and 3 levels of exchangeable sodium (approx. 0, 20, and 40 percent). Beans were grown in 2-gallon pots containing 16 pounds of soil per pot. Yield data presented in the accompanying table show that the response to base saturation and exchangeable sodium varied greatly among the 3 soils. The Norfolk soil was most severely affected by the exchangeable sodium as reflected by the yield of tops and beans. Beans grown on the Woodstown soil were least affected. Greatest reductions in yields were obtained at 40 percent exchangeable sodium; and only a slight reduction at the 20 percent level. Beans, both tops and pods, yielded better at lower base saturations than at the higher ones. This may have been due to deficiencies brought about by liming but was not indicated by spectrographical analysis of the plants. In general, the yield of bean pods was less affected by exchangeable sodium than was the yield of bean tops. A previous experiment with similar treatments on a Sassafras soil gave similar results.

The chemical composition of the bean tops was also affected by lime and sodium treatments, as shown in the table. The sodium content at the 20 percent exchangeable sodium level was very slightly more than that to which no sodium had been added. At the 40 percent level, a very large increase in sodium uptake was observed. No significant effect

Root development of four grasses on Cecil sandy loam soil, Athens, Ga.

of base saturation on the uptake of sodium was observed. The calcium content of the plants, however, increased with increasing base saturation, but, at a given base saturation level, the calcium content decreased with increasing sodium saturation. It is probable that this decrease resulted from the decrease in exchangeable calcium content with increasing sodium saturation at a given base saturation level.

Results indicate that both degree of base saturation and exchangeable sodium percentage can influence crop yields. It remains to be determined whether or not exchangeable sodium will be accumulated to any significant degree by application of brackish waters to soils in a humid area.

The effect of base saturation and exchangeable sodium percentage on the growth of beans on three soil types, Norfolk, Va.

Soil	Yield of bean tops and pods, and Na. and Ca. content of tops								
	Percent base saturation								
	50 E.S.P.*			75 E.S.P.*			100 E.S.P.*		
	0	20	40	0	20	40	0	20	40
	Yield of plant tops - g. per pot (dry wt.)								
Norfolk.....	11.1	6.4	0	10.3	7.6	2.3	8.1	5.6	1.1
Woodstown.....	11.1	8.7	6.0	10.6	10.2	5.2	10.1	9.8	7.3
Bladen.....	14.8	11.0	--	13.6	11.4	7.4	7.3	5.6	2.4
	Yield of bean pods - g. per pot								
Norfolk.....	49.3	22.3	0	47.3	49.6	0	23.3	25.7	0
Woodstown.....	69.6	59.3	31.2	64.5	59.1	48.4	62.3	57.8	45.2
Bladen.....	58.9	68.2	--	61.3	60.4	52.9	50.9	26.7	1.6
	Sodium content of tops (meq./100 g.)								
Norfolk.....	1.3	4.6	--	1.3	2.5	46.3	1.3	2.6	41.0
Woodstown.....	1.2	5.3	10.8	1.4	2.0	21.9	1.7	2.2	6.1
Bladen.....	1.1	6.7	--	1.2	1.9	27.6	1.4	2.9	25.0
	Calcium content of tops (meq./100 g.)								
Norfolk.....	91	55	--	112	119	73	131	121	65
Woodstown.....	98	74	59	132	122	84	178	143	115
Bladen.....	90	90	--	153	123	98	173	134	96

*Exchangeable sodium percentage

California

NEW PROCEDURE DEVELOPED FOR DETERMINING NA IN WATER

C. A. Bower, Riverside.--An experimental sodium alumino-silicate glass electrode supplied by Beckman Instruments, Inc. has been studied to determine its sensitivity to the cations commonly found in irrigation waters and in water extracts of soils. The lea of the electrode is attached to a conventional pH meter having a millivolt scale. A standard saturated KCl-calomel electrode with fiber-type salt bridge completes the measuring cell. The electrode has been found to be insensitive to Ca^{++} and Mg^{++} but sensitive to

Na^+, K^+, and H^+, giving theoretical relations between electromotive force and cationic activities for the latter.

A procedure for determining Na in waters and in saturation extracts of soils has been developed. It involves dilution of the sample so that the total cation concentration does not exceed about 10 me./l., adjustment of the pH value to the range 5 to 8.5, and precipitation of K as K tetraphenyl-boron prior to making electromotive force readings. The electrode is calibrated by making electromotive force measurements on two or three standard NaCl solutions having the same temperature as that of the unknown samples. The Na concentrations of irrigation waters and saturation extracts as determined by the electrode and by flame photometry agree closely.

North Dakota

IMPOUNDED RAINFALL WILL PARTIALLY DESALINIZE SOIL

Fred M. Sandoval, Leo Benz, Rome Mickelson, and Carl W. Carlson, Mandan. -- A study is being conducted on imperfectly drained lacustrine soil in the Red River Valley near Grand Forks, North Dakota. The problem is associated with a saline water table which fluctuated from 0 to 7.5 feet during May to November 1957. The water table was below 5 feet during the growing season but rose rapidly following late August and early September rains.

The object of the experiment is to evaluate the effects of leaching (water applied artificially and rainfall) upon salt migration and wheat yields. Four treatments with 4 replications comprise the experiment.

Treatment A - Check; no attempt made to impound rainfall.

Treatment B - Impounded rainfall.

Treatment C - Impounded rainfall plus 9 inches of water on October 20, 1955.

Treatment D - Impounded rainfall plus 12 inches of water on October 20, 1955.

Results show that soil salts were quite soluable and were effectively washed down the profile by the October 1955 leachings, figure 1. Impounding of rainfall was effective in partial desalinization in the presence of a fluctuating water table. Salts migrated downward from springtime to the fall. This period might not be one of gradual salt decline but, rather, is dependent on the balance between infiltration and evaporation which controls the direction of water movement. Salts tended to return upward between the fall and spring sampling.

The effect of leaching was demonstrated on wheat yields as shown in the accompanying table and in figure 2. Percent yield increase was calculated using Treatment A as the control or base. Springtime sampling gave the best relationship between yields and soil salinity for the two years of study.

Wheat yields and relative yield increases for 2 years following initial leaching treatments in November 1955, Mandan, N. D.

Treatment	Wheat yield per acre			
	1956		1957	
	Yield	Increase	Yield	Increase
	Bushels	*Percent*	*Bushels*	*Percent*
A: Check	9.4	0	8.9	0
B: Rainfall impounded	9.8	4	10.8	21
C: Rainfall + 9" 10-20-55	12.0	28	11.3	27
D: Rainfall + 18" 10-20-55	26.2	179	18.4	107

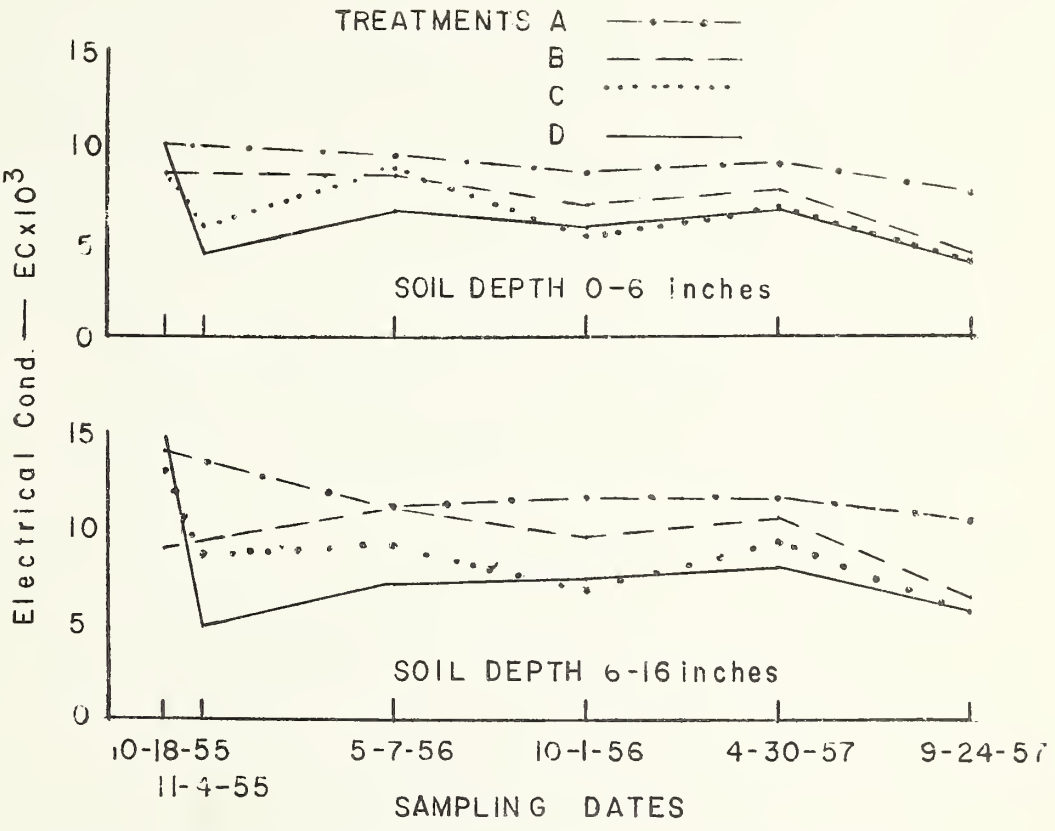


Figure 1. --Soil salinity fluctuations over a 2-year period as conditioned by treatments.

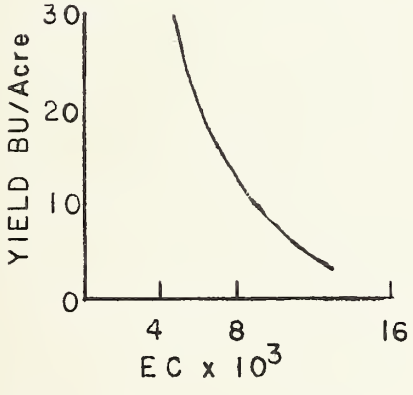


Figure 2. --Relationship between wheat yields and salinity of saturated soil extract (0-6 inch depth) at springtime.

These results were obtained on small plots which afforded the opportunity for leaching water to move laterally. Opportunity for lateral movement would be greatly reduced with leaching on a field scale, and no great improvement could be expected until the water table was lowered by drainage.

EFFECTS OF FUMIGATION ON SOIL PROPERTIES MEASURED

E. W. Hansen and T. M. McCalla, Lincoln. --Two soil fumigants, ethylene dibromide and D-D, were hand injected into field plots, which had been subtilled or plowed previously for 9 years, at the rate of 30 gallons per acre and to a depth of 6 inches. Both subtilled and plowed plots were split for treatment with ethylene dibromide, D-D, and no fumigant. Soil samples from all plots were taken at the 0-1 and 1-6 inch depths 17 and 72 days after treatment. Results are tabulated in the accompanying table.

Effect of fumigation on nematodes at different depths as influenced by tillage in a rotation[1], Lincoln, Neb.

Depth	Nematodes per 50 grams of soil							
	Plowed				Subtilled			
	A	B	C	Mean	A	B	C	Mean
	17 days after treatment							
Inches	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
0-1	55	29	135	73	226	206	272	235
1-6	10	13	200	74	31	45	159	78
Mean	32	21	168	74	128	126	216	157
	72 days after treatment							
0-1	23	12	24	20	213	74	90	126
1-6	24	28	66	39	114	56	68	79
Mean	24	20	45	30	164	65	79	103

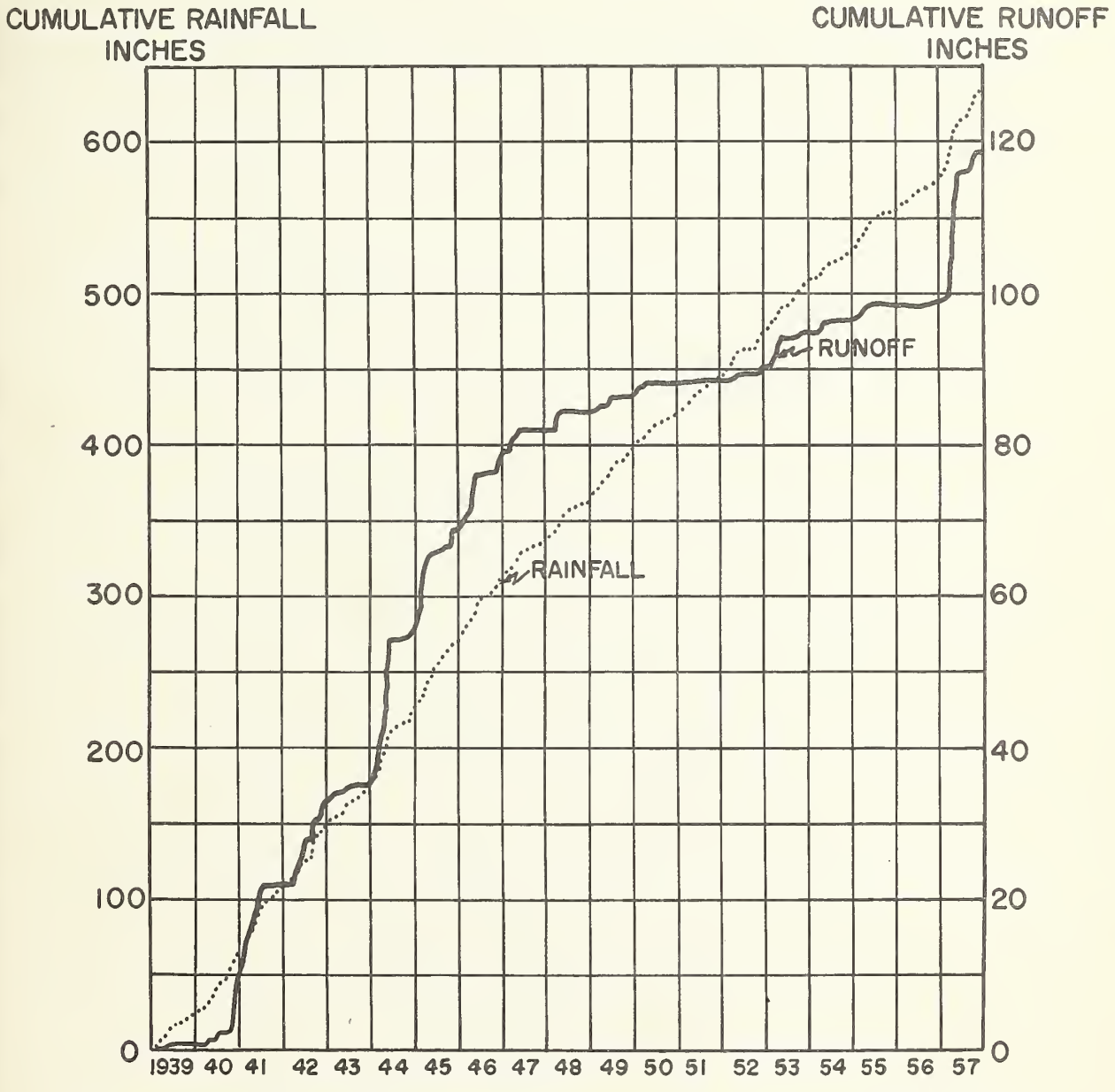
A = W-40(41 percent Ethylene Dibromide by wt.). Applied at rate of 30 gallons per acre.
B = D-D (Dichloropropene-Dichloropropane mixture). Applied at rate of 30 gallons per acre.
C = No treatment.
[1] Brome + alfalfa, 3 yrs., corn, corn, oats, wheat.

Nematodes were greatly reduced 17 days after treatment except for a minor reduction in the stubble-mulched surface inch of soil. However, the numbers of aerobic bacteria, actinomycetes, and denitrifiers were significantly greater in fumigated than in nonfumigated plots 17 days after treatment. Seventy-two days after treatment, a highly significant decrease was found in soil fungi, but no differences were observed with other organisms. No significant difference was observed in the effectiveness of 1 fumigant over another except for a reduction of nitrate-nitrogen by D-D and a decrease in percentage soil aggregation by ethylene dibromide. Nematodes, nitrate-nitrogen, acid soluble phosphorus, soil pH, and percentage soil aggregation were all highly significantly higher in the 0-1 inch soil layer, while denitrifiers were most abundant in the 1-6 inch soil layer. Aerobic bacteria, actinomycetes, and soil fungi were the same in the 2 soil depths. Wheat yields were not affected by fumigation; however, the yield on the stubble-mulched plots exceeded that on plowing by 12 bushels per acre.

Texas

MUCH OF TOTAL WATERSHED RUNOFF OCCURS IN A FEW SHORT PERIODS

R. W. Baird, Riesel. --The cumulative plotting of runoff from a representative experimental watershed for the 19-year period, 1939 through 1957, shows that a large part of the total runoff occurred during several short periods.



Cumulative plotting of rainfall and runoff from a representative experimental watershed, Riesel, Tex., 1939-57.

This record is from an area without conservation practices and with little change in land use during the period. Much of the 19-year runoff occurred in 3 periods. In the 19-year period, 118.72 inches of runoff was measured. Of this total, 9.24 inches occurred during the 3 months, Nov. 1940 - Jan. 1941; 12.83 inches occurred during April and May 1944; and 15.53 inches occurred during April and May 1957. Thus, 37.60 inches or 31.7 percent of the total for the 19 years occurred in 3.07 percent of the time period. Annual runoff for the years 1942 and 1947 also exceeded the 19-year average (6.25 inches), but it was not concentrated in short periods.

Runoff was less than the 19-year average of 6.25 inches during the 10 years, 1947 through 1956. The average annual amount for this 10-year period was only 2.14 inches. Also, during these ten years, no runoff occurred during the following periods: 1 period of 10 consecutive months, 1 period of 9 months, 3 periods of 7 months, 1 period of 6 months, and 3 periods of 5 months. During the 120 months, there were 78 months with 0.01 inch of runoff or less.

Texas

SOIL MOISTURE DISSIPATION MEASURED UNDER GRASS

M. A. Hartman and R. W. Baird, Riesel.--Various indices of soil moisture depletions are used in determining soil moisture conditions as they affect the rainfall-runoff relationship. These include pan evaporation or an estimate of pan evaporation from climatic data, rainfall-minus-runoff, and water budget computations using observed rainfall, runoff, and periodic soil moisture determinations. A comparison of the monthly moisture losses, depletions or dissipations determined by using various methods may be an indication of the adequancy of the indices.

The data given in the accompanying table and plotted in the accompanying figure are from a 3-acre native grass meadow on Houston Black clay soil near Riesel, Texas, for 1957. Water budget computations were made to determine the soil moisture (in surface inches equivalent moisture) above 18 percent for the last day of each month.

Moisture summary for native grass meadow, Riesel, Texas, 1957

Month	Soil moisture above 18% at end of month		Moisture dissipated		P-Q	Screen pan evaporation
	Top 3 feet	Top 5 feet	Top 3 feet	Top 5 feet		
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Dec. '56...	3.5	4.4	--	--	--	--
Jan.....	3.6	4.6	1.5	1.4	1.6	2.8
Feb.....	4.6	5.5	2.3	2.4	3.3	2.3
Mar.....	6.5	9.2	3.7	1.9	5.6	3.3
Apr.....	8.5	13.3	3.4	1.3	5.4	2.8
May.....	5.7	9.9	6.2	6.8	3.4	3.7
June.....	4.1	7.2	4.9	6.0	3.3	5.9
July.....	0.6	2.6	3.5	4.6	0.0	8.7
Aug.....	0.0	1.8	1.6	1.8	1.0	9.0
Sept.....	2.5	3.7	1.8	2.4	4.3	6.9
Oct.....	6.1	10.3	4.8	1.8	8.4	5.2
Nov.....	8.5	13.3	1.7	1.1	4.1	2.5
Dec.....	8.0	12.6	1.4	1.6	0.9	3.1
Total.....	--	--	36.8	33.1	41.3	56.2

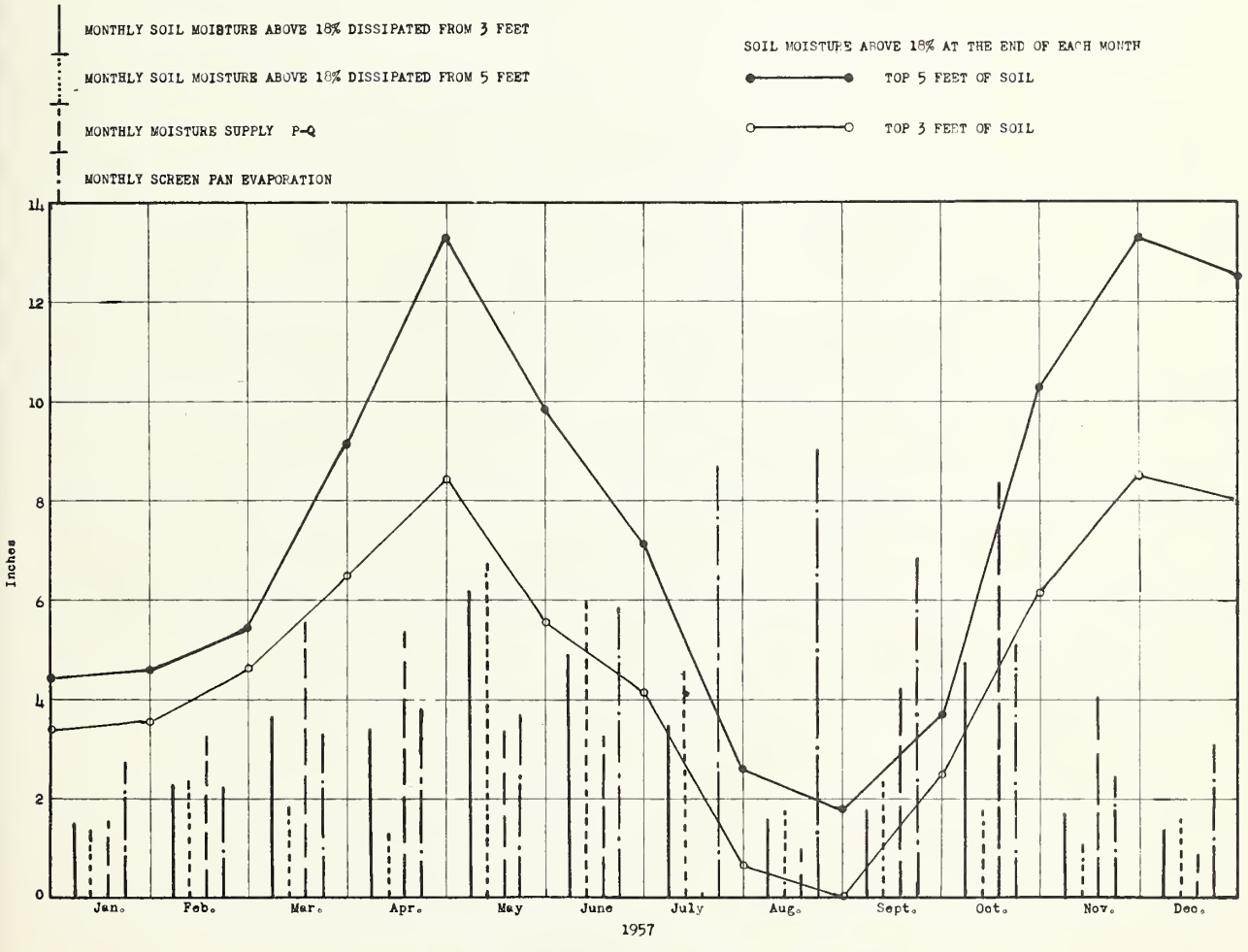
The 5-foot soil profile was the greatest depth for which data are available for estimating evapotranspiration from soil moisture records. The dissipation rates for May and June exceed pan evaporation, indicating that some dissipation was probably deep percolation. Therefore, with existing soil moisture conditions, the evapotranspiration was probably less than 33 inches (the annual total) in 1957.

The dissipation varied with the amount of water available (as indicated by the soil moisture above 18 percent). The extreme example is the low dissipation in August, when stored moisture was at its lowest.

The differences in monthly dissipation between the 3-foot and 5-foot depths can likely be explained by percolation below 3 feet and water used from the area below 3 feet. Therefore, the moisture dissipation from 3 feet is not as good an index of evapotranspiration as the dissipation from 5 feet.

The extreme monthly variations in the relationship of pan evaporation monthly supply (P-Q) to the dissipation from 5 feet indicate that monthly pan evaporation or monthly supply (P-Q) are not good indices of evapotranspiration.

The moisture supply (P-Q) may be a good index for evapotranspiration on a water year basis, provided the change in storage is negligible; in 1957, however, the change in storage (12.4 - 4.2) is 8.2 inches in 5 feet of soil; nearly 20 percent of the total supply.



Moisture changes on native grass meadow, Riesel, Texas, 1957

PRECIPITATION DIFFERS ON TWO NEARBY WATERSHEDS

J. A. Allis and F. J. Dragoun, Hastings.--Differences in rainfall intensities and amounts which occur in individual storms should be considered in comparisons of peak rates, total runoff, and sediment yields from the two 400-odd acre watersheds under study at this project.

These two watersheds, W-3 and W-5, are located within one-third mile of each other at the closest point, and the extreme distances between watershed boundaries is less than three miles. In this three mile distance, the patterns of some storms have shown considerable variation in rainfall amounts and intensities. The storm of June 12, 1958, for example, had some differences in amounts and considerable differences in intensities on the two areas. In the accompanying table, rainfall amounts and intensities at rain gage B 32 R in Watershed W-3 are compared to those one mile away at rain gage C 45 R in Watershed W-5.

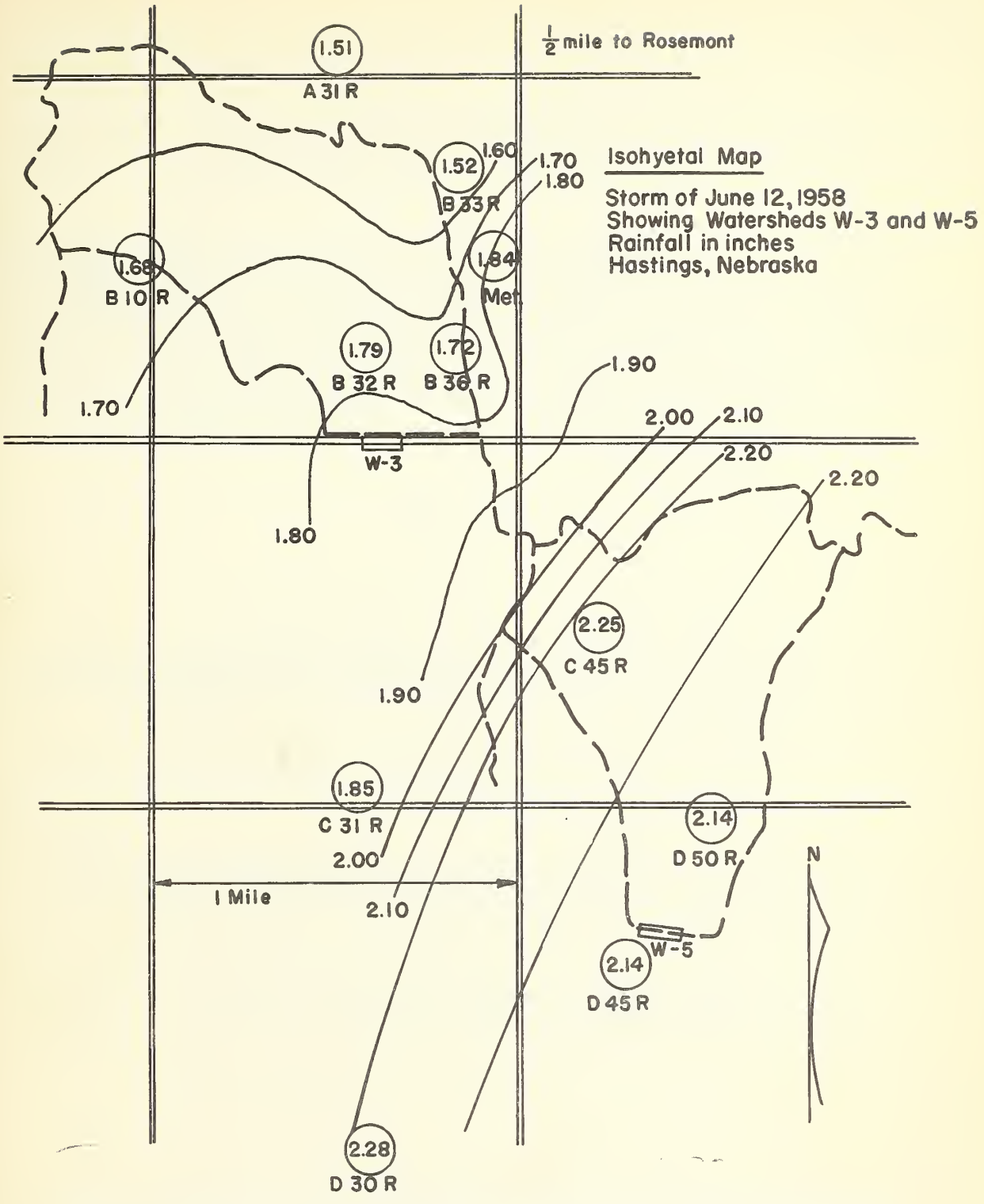
Maximum depth and intensities of rainfall for selected time intervals, rain gages B 32 R and C 45 R, Hastings, Neb. June 12, 1958

Rain gage	Watershed	Amount and intensity of rainfall									
		Time in minutes									
		5		10		15		20		30	
		Depth	Inten.	Depth	Inten.	Depth	Inten.	Depth	Inten.	Depth	Inten.
		Inch	*In/Hr*	*Inch*	*In/Hr*	*Inch*	*In/Hr*	*Inch*	*In/Hr*	*Inch*	*In/Hr*
B 32 R	W-3	0.55	6.60	0.81	4.86	1.06	4.24	1.25	3.75	1.41	2.82
C 45 R	W-5	0.87	10.44	1.22	7.32	1.50	6.00	1.72	5.16	1.91	3.82
Ratio: $\frac{W-3}{W-5}$			0.63		0.66		0.71		0.73		0.74

These gages are usually the most representative gages in the respective watersheds.

The accompanying isohyetal map shows the variation in total rainfall for the storm of June 12, 1958. The Theisen weighted rainfall was 2.21 inches on Watershed W-5 and 1.69 inches on Watershed W-3, or 0.52 inches more rainfall on Watershed W-5.

It is possible that, over a period of time, the differences in individual rainfall events on the two watersheds will be compensating; however, more confidence can be placed in runoff and sediment yield comparisons on the two watersheds if proper consideration is given to differences in rainfall.



Isohyetal map showing variation in total rainfall for storm of June 12, 1958 on two watersheds, Hastings, Nebr.

Wisconsin

FIRST HEAVY STORM OCCURS ON COLBY EXPERIMENTAL WATERSHED

N. E. Minshall, Madison.--Collection of records on the 345-acre area at Colby, Wisconsin, began in May 1949. Since that time, no unusual storms have occurred; and the annual precipitation has averaged about 4 inches below normal for the entire period of record. The precipitation for September 1957 through May 1958 shows a deficiency of about 8 inches from normal.

On June 4, a heavy storm finally occurred on this area in connection with a tornado which passed through some 3 miles to the north. This storm had a total precipitation of 3.17 inches in 1 hour and 17 minutes. Of this total, maximum amounts for various times were 1.14 inches in 15 minutes, 1.76 inches in 30 minutes, and 3.10 inches in an hour. The peak rate of runoff from the watershed was 200 cfs or 0.57 inches per hours. This is about 4 times as high as any previous peak since the studies began, but quite low considering the rainfall intensity. The total runoff for the storm was 1.27 inches or 40 percent of the rainfall. The time from beginning of intense rainfall to peak of runoff was 1 hour and 25 minutes; and the peak was flat with a rate of runoff of over 120 cfs for 1 hour. The time from the center of the mass of rainfall until half of the runoff had passed the gaging station was 2 hours.

SEDIMENTATION

Kansas

VOLUME WEIGHT OF SEDIMENT IS RELATED TO PARTICLE SIZE

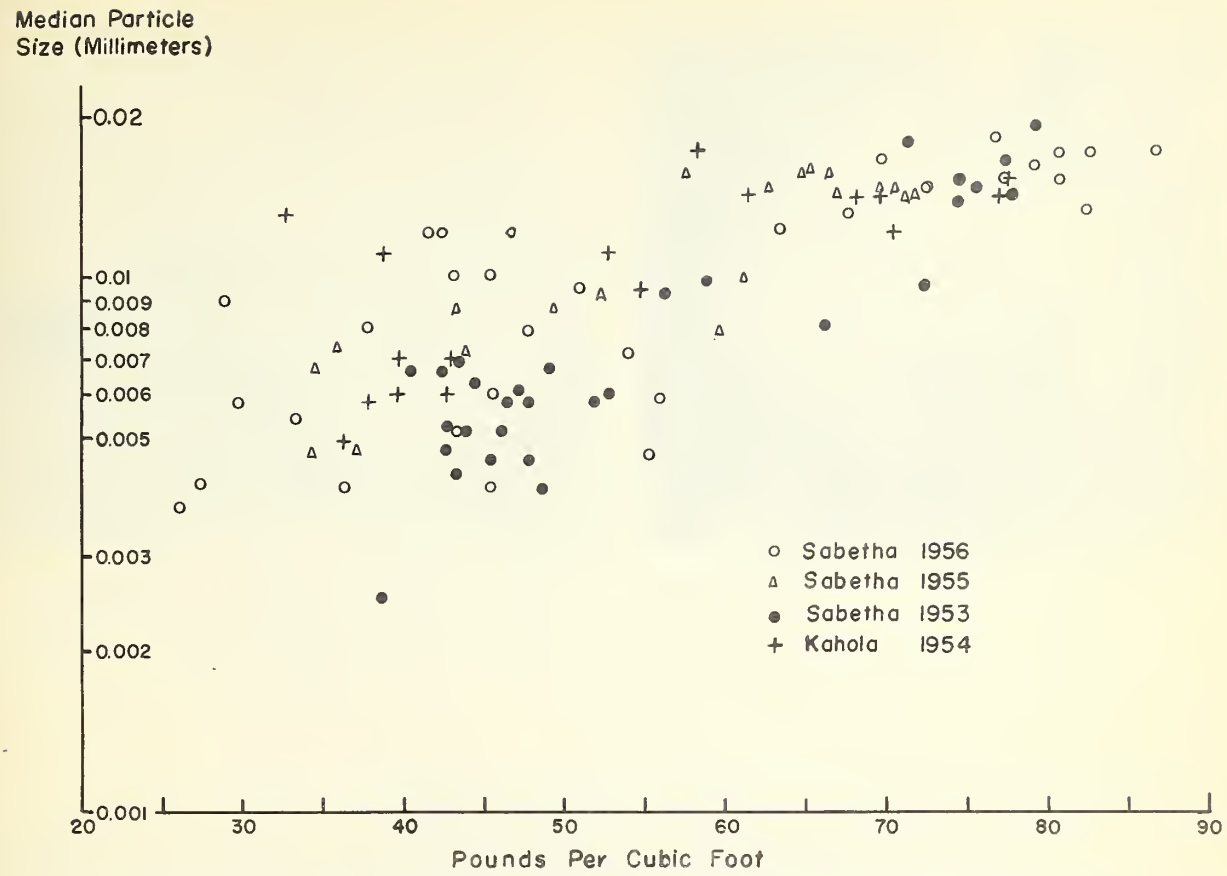
Herman G. Heinemann, Lincoln.--The relationship between the median particle size and the volume weight of sediment taken from deposits in the Sabetha and Kahola reservoirs in Kansas is plotted in the accompanying figure. This plotting shows that a definite relationship exists.

The Sabetha watershed is located in Nemaha County in the northeastern corner of the State and Kahola reservoir is located in the "Bluestem" region of Morris and Chase Counties in the central-eastern portion of Kansas.

The spread in volume weights for a particular median particle size is probably due to different degrees of compaction of the reservoir sediments--these samples having been taken from the top few inches to depths of 74 inches of deposit.

These samples are obtained by using three samplers as follows:

S. C. S. Brass Tube Sampler--Approx. 9 percent of samples
U. S. G. S. Hand Sampler--Approx. 22 percent of samples
2-7/8" I. D. Vacuum-Plunger Type Sampler--Approx. 69 percent of samples



Volume weight vs. median particle size of sediments deposited in Sabetha and Kahola reservoirs, Kansas

HYDRAULICS

Colorado

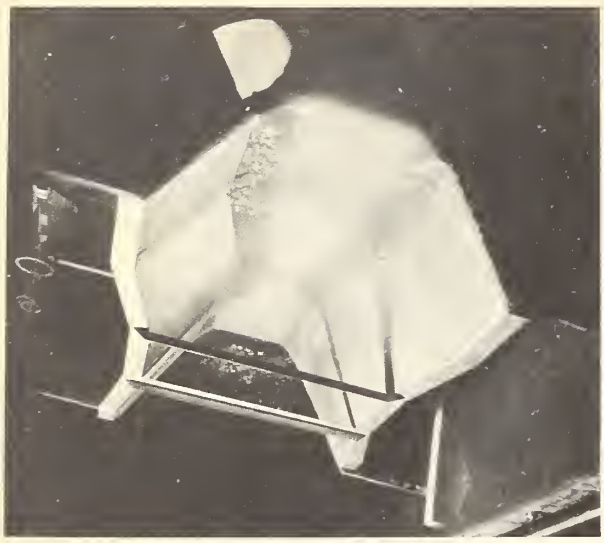
TRAPEZOIDAL FLUMES SHOW PROMISE FOR MEASURING WATER

A. R. Robinson, Fort Collins. --Tests under way on measuring flumes having sloping sidewalls indicate that they possess features which are superior to other flume designs now in existence. These features include:

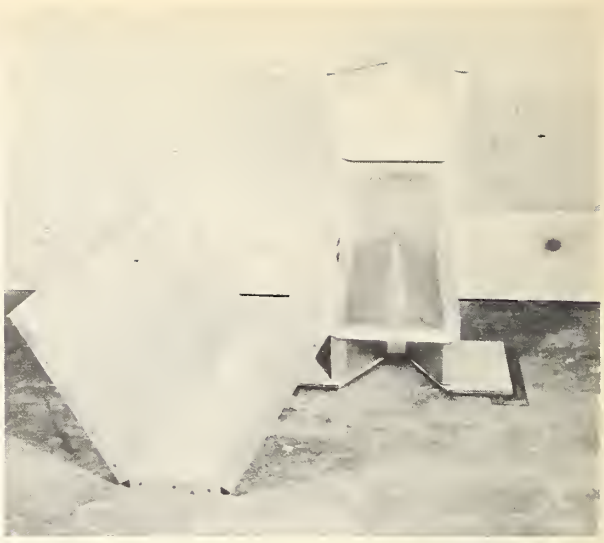
1. Operation under greater degrees of submergence without corrections being applied.
2. A large range of discharge for a relatively small change in depth of flow.
3. A shape which more nearly fits the common canal or furrow cross section.
4. Ease of construction.

Some of the devices tested are shown in the accompanying photographs.

The variables being investigated are the angle of the side walls, length of the throat section, and design of the converging and diverging sections. The side-wall angle has been varied from 30 to 60 degrees from horizontal. It is anticipated that the small V-notch flumes will find primary use for furrow measurements. The larger flumes which have a flat bottom throughout can be built to any desired size.



Trapezoidal flume with 4-inch throat and 60 degree side walls. Discharge ranges from 20-1200 g. p. m., Ft. Collins, Colo.



Trapezoidal flumes showing one with a 2-inch throat and the other with a V-bottom. The discharge for the V ranges from 2 to 120 g. p. m. and for the 2-inch from 7 to 500 g. p. m., Ft. Collins, Colo.

Minnesota

CLOSED CONDUIT SPILLWAY PAPERS BEING PUBLISHED

Fred W. Blaisdell, Minneapolis. --Four technical papers covering the theory and results of tests on closed conduit spillways have been prepared for publication. The first report is a revision of the paper on the theory of closed conduit spillways which first appeared in 1952. The second paper is a report on all tests conducted on closed conduit spillways by the Agricultural Research Service between 1940 and 1952. The third paper covers model tests and field tests, some of which were conducted during the 1930's. The fourth paper is a technical report on the tests of the hood inlet. The titles of these papers are:

Hydraulics of Closed Conduit Spillways--Part I. Theory and Its Application. Technical Paper No. 12-B, St. Anthony Falls Hydraulic Laboratory, February 1958.

Hydraulics of Closed Conduit Spillways--Parts II-VII. Results of Tests on Several Forms of Spillway. Technical Paper No. 18-B, St. Anthony Falls Hydraulic Laboratory, March 1958.

Hydraulics of Closed Conduit Spillways--Part VIII. Miscellaneous Laboratory Tests. Part IX. Field Tests. Technical Paper No. 19-B, St. Anthony Falls Hydraulic Laboratory, March 1958.

Hydraulics of Closed Conduit Spillways--Part X. The Hood Inlet. Technical Paper No. 20-B, St. Anthony Falls Hydraulic Laboratory, April 1958.

Copies of each of these papers will be distributed to each State Office and to the Engineering and Watershed Planning Units of the Soil Conservation Service.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of the Soil and Water Conservation Research Division are listed below.

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Armiger, W. H., Dean, L. A., Mason, D. D., and Koch, E. J. Effect of size and type of pot on relative percision, yields, and nutrient uptake in greenhouse fertilizer experiments. Agron. Jour. 50: 244-247, illus., 1958.

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Army, T. J., Dickey, D. D., and McNeal, F. H. The effectof barley stripe mosaic on the phosphorus content of eight spring wheat varieties. Plant Dis. Rptr. 42: 747-749, 1958.

Barnes, O. K., and Bohmont, D. W. Effect of cropping practices on water-intake rates in Northern Great Plains. Wyo. Agr. Expt. Sta. Bul. 358: 20 pp., illus., 1958.

Bernstein, Leon, and Hayward, H. E. The physiology of salt tolerance. Ann. Rev. Plant Physiol. 9: 25-46, illus., 1958.

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Box, J. E., and Lemon, E. R. Preliminary field investigations of electrical resistance-moisture stress relations in cotton and grain sorghum plants. Soil Sci. Soc. Amer. Proc. 22: 193-196, illus., 1958.

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Chandler, W. V. Effect of long-time surface fertilization on rooting depth and habits of oats. Agron. Jour. 50: 286, 1958.

Chepil, W. S. Soil conditions that influence wind erosion. USDA Tech. Bul. 1185: 40 pp., illus., 1958.

Chepil, W. S. The use of evenly spaced hemispheres to evaluate aerodynamic forces on a soil surface. Amer. Geophys. Union Trans. 39: 397-404, illus., 1958.

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